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GORDON F. FERRIS MEMORIAL ISSUE

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The Pan-Pacific Entomologist

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GORDON FLOYD FERRIS—1893–1958

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For some individuals, a full biography is justifiable only as a matter of record. With Gordon Floyd Ferris the situation is different. Here was a man of originality with much to tell to the world and a gifted pen with which to tell it. In a life devoted to principles as he saw them and to ideals as he conceived them, there emerged a profound truth which, unfortunately, he never put into words. It is that a scientist, endowed with ability and placed in a favorable environment, has an overwhelming obligation to produce for the society that supports him. This obligation, as Ferris saw and filled it in fullest measure, was not necessarily to produce practical results but rather to seek the truth in all things and to make the results known. It happened that some of the work that Ferris did with lice and scale insects was of direct importance to mankind. But he insisted that his interest in these insects had no connection with their actual or potential economic importance. Instead, he was motivated solely by the fact, mystical or otherwise, that he liked them. In a moment of self analysis (Canad. Ent. 56:25, 1924) he wrote on this as follows:

"I have often wondered what it is that determines our special interests. Why does one entomologist prefer to work on dragonflies, another on butterflies and a third on beetles? . . . If we were to study man as we do other animals we would doubtless devise a special terminology to 'explain' these things. We would say that so-and-so is positively hemipterotropic or papiliotropic, or whatever else it may be, and let it go at that with a rather comfortable feeling that we have disposed of the matter! . . . As for myself, I am irresistably drawn toward the smallest and most intrinsically uninteresting of insect forms. I can appreciate the pleasures of the collector who looks with gloating eyes upon his well-filled cabinet of glorious butterflies or gleaming beetles, but I can not expect him in turn to do more than wonder why I also should look with the same feelings upon a well-filled cabinet of little pieces of glass, each one with one or two minute specks in the centre of it.

GORDON FLOYD FERRIS (1893 - 1958)

But it is so, and my knowledge of ancient languages is not sufficient to enable me to coin a word behind which it is possible to take refuge. I merely know that if an insect is too large to go on a slide I leave it for someone else, and if it is small enough to go on a slide I have an impulse to put it there."

Throughout his life Ferris, who was a large man, maintained this interest in small insects.

Early life. The following quotation is from a brief biographical sketch prepared by Ferris shortly before his death:

"Born January 2, 1893, at Bayard, Allen County, Kansas, a "tank town" where his father was a gandy dancer on the railway. He was the fifth child and the fourth boy in a family of five. When he was between two and three

years old the family moved to a 40-acre farm near Monticello, Cedar County, Missouri, where they lived in a one-room log cabin. When he was a little more than three years old his mother died after giving birth to another son, who also died while still young.

" . . . He and his sister went to live with his paternal grandmother and an unmarried uncle on a farm near La Harpe, Allen County, Kansas. At the age of about 10 years the grandmother died . . . His father thereupon moved to La Harpe with the two brothers who had remained with him, obtained employment as a day laborer in a zinc smelter . . . and . . . established a "bachelor" home in La Harpe with the two brothers.

"Gordon remained with his father until he was 13, except for two summers spent as a hired hand on a farm near Iola, Kansas. In the meantime his oldest brother, Leslie, . . . had enrolled at Ottawa University, a small Baptist college at Ottawa, Kansas, where he acted as the local circulation agent for the *Kansas City Star*. When Gordon graduated from the eighth grade at La Harpe, at the age of 13, Leslie had him come to live with him. With the support of Leslie and such money as Gordon could make by carrying papers . . . he remained at Ottawa until 1909, having in the meantime graduated from the "academy" at Ottawa University . . . Leslie graduated from the college in 1909 and secured a position as a teacher in the high school at Telluride, Colorado. He left Gordon as circulation agent for the *Kansas City Star* in Ottawa and Gordon entered Ottawa University as a freshman in the fall of 1909. He was a complete failure at this, withdrew from the college, and proposed joining the Navy as soon as he became 17.

"It was necessary to obtain the consent of his father to join the Navy. The papers were sent to his father, who refused to sign them without first consulting Leslie. Leslie refused to give his consent and instead secured a place for Gordon with the Telluride Power Company at Telluride.

" . . . In its early days the Telluride Power Company had trouble securing trained men, and under the leadership of L. L. Nunn, its founder, had established the practice of employing young men at reduced salary and after a time sending them to college. Out of this grew the Telluride Association, an endowed institution, entirely apart from the power company . . . In the spring of 1911 Gordon was transferred to the station of a power company at Olmstead, Utah, where the Telluride Association ran a school for its members.

"The Telluride Association maintained a house at Cornell University, where most of its men who were selected for "preferment" went. Gordon disapproved of the social emphasis at this house and asked instead to be sent to Stanford University. He had seen Kellogg's *American Insects* while he was at Ottawa, and Kellogg—then a professor at Stanford—was the only entomologist he had ever heard of. In the summer of 1912 he was granted $450 by the Telluride Association and came to Stanford. With the continued support of the Association—never amounting to over $500 a year—he finished his work for the degree of M.A. in 1917.

"He was then appointed a teaching assistant in entomology at Stanford and further data will be a matter of record."

Field work. To those whose only contact with Ferris was in the laboratory or classroom it will come as a surprise to learn that he was a dedicated field naturalist. He had been at Stanford for only one year when, doubtless through an interest in ectoparasites kindled by Vernon Kellogg and the contact with Joseph Grinnell, he joined a field party of the University of California Museum of Vertebrate Zoology. The trip covered the north coast counties of California. According to C. L. Camp, who was a member of the party, (personal comm.) Ferris' main job was to comb the vertebrates for ectoparasites, but the bound collection of field notes in the MVZ files shows that the 20 year old student's interests ranged widely and his handwriting, which he always deprecated, was already, at that early age, nearly illegible. On July 24, 1913, three miles south of Covelo, Mendocino County, he wrote: "While out hunting butterflies in the afternoon I heard a loud squeak in the oak tree above my head and looked up just in time to see a small wood rat come hastily out of a pile of sticks on a limb and run rapidly down the tree. I could see the folds of a snake in the sticks and upon shooting into them, a large gopher snake, perhaps three and a half feet long, fell to the ground. It lay beneath some sticks and produced a rather loud buzzing sound by beating the tip of its tail against a stick. It escaped into a hole when I attempted to capture it." Two years later Ferris joined another MVZ team and collected ectoparasites from birds and mammals in the Yosemite region.

Other extensive field trips included: Lower California, with J. R. Slevin (1919); Southwestern United States investigating lac-producing scale insects with Roxana S. Ferris (1918) and daughter Beth and C. D. Duncan (1920); Mexico (Guggenheim Grant) (Fall of 1925 to summer of 1926) visiting Sinaloa, Nayarit, the Tres Marias Island, Colima, thence south by foot to Acapulco, the east and west coasts of the Isthmus and Mexico City; Lower California, with Shreve, Mallory and R. S. Ferris, crossing over to Sonora on return (March and April, 1934); Panama including the Volcan de Chiriqui, Puerto Armuellas, David and Boquete (summer of 1938); Arizona, with L. P. Wehrle and R. S. Ferris (1940); China (Fulbright Award) including Yunnan, Hong Kong, and New Territories, Kwangtung and Taiwan (Fall of 1948, spring, 1949). Also Ferris spent a year studying Anoplura at the

Molteno Institute, Cambridge University and at the British Museum (Natural History) (1930–1931).

As in other facets of his life Ferris was unpretentious in his field work. He pointed this up in an unusual article in the *Scientific Monthly* titled "Scientific Exploration, A Phantasy" (Sci. Mon. 27:537–541, 1928). In the story a lone and weary collector pitches camp and falls into a fitful slumber broken by bouts with tropical fever. He dreams of a super expedition supplied by airlift with the most elaborate equipment and the most luxurious food. Being depedent on money in large amounts brought in by public relations men it is finally decided that the scientists, who are merely an impediment, must go. Although facetious, the lone scientist is obviously Ferris and the great expedition could be any one of a number organized in recent years.

Systematics. Ferris was primarily a taxonomist and in this, as in other activities, he brought a fresh approach and a plan for work. Starting with the lice under Kellogg and the Coccidae under Doane he soon set a pattern from which he deviated but little in later years. Foremost was his insistence on detailed drawings—doubtless as a reaction to the shocking state of knowledge of lice and coccids based largely on inadequate descriptions. In his first paper, with Vernon Kellogg, the drawings are not divided by a vertical line into ventral and dorsal halves, but he soon adopted this economical method and gave his philosophy on drawings in 1923 (Sci. 58:266): "A scientific illustration is not intended merely as a pretty picture and it has nothing to do with art. Its purpose is merely to present in the simplest and most accurate manner the things that it is desired to show and its production involves nothing more than good draftsmanship. If in addition to these qualifications it is also artistic—whatever that may mean—so much the better." The arguments for divided drawings were given as follows: 1) they save in cost of blocks; 2) they save in the time of making drawings; 3) they save space in printing; 4) they are more convenient because both sides can be readily compared.

Once started on the course of drawing details of minute insects instead of describing them, Ferris was committed to a compound microscope and pen and ink for the rest of his life. With prodigious energy and usually with several projects running concurrently he turned out monumental works. He provided the foundations for

our present knowledge of the Anoplura, Mallophaga, Coccoidea, Diptera-Pupipara, Cimicidae and Polyctenidae. Probably no man has ever made so many original detailed drawings of insects.

The cost of reproduction of illustrations was a constant problem in his papers which reversed the usual ratio between text and figures. To solve this Ferris turned to off-set lithography in place of conventional letterpress. The result was Microentomology, his own journal, in the Foreword (Microent. 1:1, 1936) of which he states his "intention to speak as far as is practicable through the medium of illustrations of which the text will be merely explanatory and confirmatory." This emphasis was shown in the papers that we published together on Polyctenidae and Cimicidae. Ferris devoted himself exclusively to the illustrations (which of course could stand alone) and left the text entirely to me.

Although the off-set method reduced costs, the size and number of Ferris' publications raised problems of financing. Curiously, the Atlas of Scale Insects was his greatest problem and required the largest outlay of private funds. Here was a work of great economic importance, a standard reference for economic entomologists, yet such was the attitude in support of scientific work before and during World War II that Ferris announced his intention (fortunately not carried out) to abandon the project after Series IV. He reasoned that, "If the world wants this Atlas of the Scale Insects of North America completed the world must find some way to pay for it." That the world did find a way to pay for it is no great credit to the "world" because it was only after Ferris had contributed not only the scientific work but also a substantial amount of money that the work was continued. As early as 1919 Ferris wrote an article (Science, 50:543): "Why not government-maintained fellowships?" but it took a cold war to bring us to the present level of support for the things that Ferris strove for.

The first and only "book", as distinguished from monographs, atlases, etc., written by Ferris was "The Principles of Systematic Entomology" (Stanford University Publications, University Series, Biological Sciences, Vol. 5, No. 3, with reprints bound and sold separately). Here again we see freshness and originality and something else that came to be a trademark. Sometime during the 1920s Ferris developed a style of writing that became stately but not pompous. As a first statement of the principles of a science his

book stands as a classic. The principles stated in this book are sound and were a part of Ferris' own life and work. However, it is necessary to point out that his strongest asset—originality—led to a weakness which will probably not be serious because it can be supplied by later workers. Ferris assumed that all work previous to his own in a group was of dubious value and not worth the trouble to look up. As he put it: (Microent. 13(3):52, 1948) "We would seem to be justified in the assumption that a very large part of what was done in the earlier years is likely to be either wrong or inadequate." Continuing (Microent. 15(4):127, 1950): "What is to be gained by laborious attempts to disassociate fiction from fact until some basis for judgment has first of all been established? Let us begin with first things first, and proceed then step by step." This, to my knowledge, has been the main basis for criticism of Ferris' work, a small but unnecessary price to have paid for such an original and productive life.

The Plant Quarantine Controversy. Ferris was a fighter in the cause of freedom. He saw in the inspection of personal belongings at the borders of California an infringement of the rights of citizens. This led to a frontal attack on the government agencies dedicated to eradicating the Mediterranean Fruit Fly from Florida. It also led, unfortunately, to personal feuds with friends and colleagues in entomology but the outcome, looking back after 20 years, was beneficial to everyone. Ferris' position was stated as follows (Science, 70:452, 1929): "Theoretically, perhaps, the fruit fly can be eradicated [it was!]. Theoretically *any* insect can be eradicated—at a price. A country can be converted into a desert. Its inhabitants can be ruined. It can be depopulated . . . Even should the fruit fly be for the time being 'eradicated'—from a biological point of view a most improbable outcome—at whatever cost, it will inevitably come again [it did!] and the whole performance must again be gone through. Those who believe that any quarantine can guarantee future immunity are leaning upon a hollow reed." In a later article (Science, 71:606, 1930) he states that, "It would seem desirable for the supporters of these measures to enlarge the range of their view sufficiently to include a larger proportion of the facts of the situation."

Summarizing his case against the "agricultural bureaucrats" for their "kill or cure policy" and for wasting millions of dollars of the taxpayers' money on what he regarded as an unsound

biological principle, he suggested that a commission be appointed "to consider with a cold and critical eye the whole question of plant quarantines from biological, sociological and legal points of view." This was done and the final report, produced after several years work by a team of highly competent university and government scientists, was reviewed by Ferris with a final comment as follows: "It is a tribute to the intellectual honesty of the members of the committee that the reviewer—an avowed enemy of the quarantine system—can think of no critical phrase to apply to the report more condemnatory than 'unduly cautious'."

Scientific Affiliations. Ferris was not an "organization man" or "joiner", yet he had certain deep seated loyalties. His scientific "home" away from the Stanford campus was the Pacific Coast Entomological Society. He was elected a member of the Society at the 74th meeting on December 13, 1919, at which time he reported on his recently completed trip to Lower California. My first acquaintance with Ferris was at Society meetings in the late 1920s, held in Room 10 of the San Francisco Ferry Building. At first it was a mystery to me why Ferris attended because the meetings were dominated by talk of beetles and butterflies and the philosophy of the long-time president, E. C. Van Dyke. I remember in the depression years sitting on the publication committee of the Pan-Pacific Entomologist when the "hat was passed" to make up each year's deficit. Ferris always contributed what impressed me as large amounts.

The most important part played by Ferris in Society activities was his association with successive generations of students from neighboring universities. Hundreds of students outside his own Stanford group came to know him in this way. Usually, he would bring a folder of drawings and lay them out on a table for inspection. Or, in later years, he would present a controversial point in morphology.

Morphology. Ferris liked to tell this story of his entry into the field of comparative morphology. He was invited to do the chapter on morphology for the book "Biology of Drosophila" as originally planned by A. F. Heutter in 1939 and finally published under the editorship of M. Demerec in 1950. According to Ferris this commitment led him back to the primitive Diptera (Tipulidae), thence to the Mecoptera and finally back to the segmented worms (Annelida). Whether the sequence is literally true, I cannot say,

but this much is certain: Ferris had always been interested in structure as revealed by the techniques used for preservation of his small insects. Then, in the mid-1930s, he was profoundly influenced by the breadth of thinking of a newly formed discussion group in California, the Biosystematists, made up of active students of evolution representing various disciplines in the biological sciences. Thus began another of the major developments in his varied career. Although continuing with the detailed drawings for the "Atlas of Scale Insects" it was clear that his main interest and intellectual challenge was comparative morphology in its broadest sense.

In typical fashion he started with a firm set of principles and with a plan, almost a schedule, for production. Some idea of the scope of his thinking may be obtained from the following quotation: (Microent. 13(3):55–56, 1948) "When—far in the future—we really have a sound and broad knowledge of insect morphology, we shall be able to see, upon the stage of that magnificent theater of biological processes which have produced the greatest of all animal phyla, the Arthropoda, the unfolding and flowering of the processes of evolution with a clarity and degree of detail that can nowhere else be attained."

Characteristically, Ferris found himself almost immediately upon entering the field of morphology, embroiled in controversy. He found the field occupied by static concepts and dominated by principles that he regarded as unsound. Accordingly, he advocated the following methodology for comparative morphologists:

1. Every structure that is present in the organisms with which we are concerned and which is pertinent to our immediate problem must be seen and seen correctly. This implies the search for suitable material; the proper preparation and manipulation of the material; the possession of and the ability to use adequate optical equipment and associated techniques; the training of the eye to see and of the mind to appreciate what is seen; and the rigorous testing and checking of what is believed to have been seen.

2. Every structure which is seen and which can be pertinent to the investigation in hand must be taken into consideration and must be accounted for morphologically. No structure may be dismissed as having no morphological significance until its origin and significance have been carefully explored. Nothing may be dismissed as "merely there."

3. It should be clearly recognized that comparative morphology is not merely the comparison of the end products of evolution. Little is to be gained by the direct comparison of highly specialized forms. These end products must first be related to the less specialized ancestral forms, from which alone an understanding of them is to be derived, before they can be compared with each other.

4. Discrepancies must be accounted for. In attempting to account for them, the first assumption on which to proceed is that there has been an error of observation. The next is that there has been an error of interpretation. And if the discrepancy still persists, it is not to be accepted as representing a condition that may be dismissed. It still remains an unsolved problem that calls for solution.

Ferris maintained that most students of morphology violated these principles either occasionally or consistently. His opponents, in turn, challenged his facts and conclusions. Criticism was especially directed toward his interpretation of the insect head (Manton, S.M. 1949, Phil. Trans. Royal Soc. London, B, Biol. Sci. 233:483–580). Ferris replied in a fiery note (Microent. 15(4):127, 1950) as follows: "This idea of the adaptational shifting of the mouth is one which could have been tenable in the days of Lankester but which now is about on the intellectual level of a belief in witchcraft. Not until such remnants of folklore have been entirely discarded can the problems of comparative morphology be reduced to a logical basis and a consistent system be developed. They are like believing in ghosts without reflecting upon the source of energy for these ghosts and their manifestations."

The last word has not been said on the Ferris school of comparative morphology but a few generalizations seem to be warranted. First it is clear that statements in the literature on absence of homologies in genitalia, mouthparts, or other obviously comparable structures in insects are naive, unwarranted, or unsoud. Whether Ferris, on the other hand, has provided sound interpretations on such subjects can only be determined by time and the work of many investigators. Second, it seems clear that morphological literature contains many errors of observation and interpretation. Whether Ferris, or his students have also erred is a question for future morphologists to determine.

Meanwhile, Ferris has given us six hypotheses which he re-

garded as basic to his philosophy of comparative morphology.

"1. We postulate that evolution has been continuous and orderly, each change being based upon a stage that has gone before. To assume otherwise, to assume that evolution has been discontinuous and has proceeded by steps of great magnitude and unrelated to anything that has gone before, is to surrender at the very beginning any possibility of testing either assumption and of determining whether or not such changes of great magnitude have actually occurred.

"2. We postulate that all evolutionary changes have arisen from changes in the genetic materials and are transmitted only in accord with the laws of genetics, whether those laws are now completely known or not.

"3. We postulate that evolutionary changes are first to be accounted for by modifications of pre-existing structures; by fusions of pre-existing structures; or by loss of pre-existing structures. Only after these possibilities have been exhausted will we assume that a completely new structure has been developed. This is in accord with the principle of parsimony; the validity of the postulate has thus far been substantiated in practice.

"This is a direct reversal of procedures that have frequently been followed by investigators, some of whom, when confronted by a difficulty, have immediately resorted to the assumption that even a whole new system has been evolved to replace a previous system. This has been done time after time and is fatal to the development of any consistent and coherent system of comparative morphology.

"4. We postulate that evolution has not been merely endless change involving all structures of the body. There are structures which have remained stable while everything about them changed. It is these structures which constitute the bases upon which the student of comparative morphology depends for the tracing of continuity. These are the 'landmarks', the importance of which is known as a matter of experience, and search for them is one of the primary activities of comparative morphology.

"5. We postulate the necessity for and the justification of a faith that somewhere in the great mass of material offered to us by the Annulata there will be an answer to any morphological question that may arise. We shall assume that, if the answer is not immediately forthcoming this is most likely due to the lack

of suitable material, a failure to interpret available facts correctly, or the inadequacy of our own mental processes. To begin with the assumption that the answer does not exist is to admit defeat before the matter has been put to a real test.

"6. We postulate that it is not the business of the student of comparative morphology to inquire into the function of a structure. It is his business merely to trace the history of the structure. We are not concerned with whether a leg is used for walking, or for digging, or for leaping, or for grasping, or for swimming. We are concerned only with the question of the morphological origin of that leg and its parts.

"Thus armed with the general principles that have proven valid and useful in the development of other types of scientific investigation, with a methodology, and with a set of at least preliminary hypotheses that are subject to test, we are in a position to proceed. We may pass on to the consideration and the pursuit of individual problems which may offer some answer to the broad question with which we began, that of whether or not the comparative morphology of the Annulata can contribute something to the understanding of the general problem of evolution."

General Characteristics. It is interesting and perhaps useful to consider the characteristics that make for greatness. Foremost among these, perhaps, is motivation or drive coupled with a sense of social responsibility. No less important for a teacher is personal humility, sympathy and generosity to one's fellow men. Then, in a scientist, there is a need for technical competence in his special field, imagination to conceive large works, patience to carry them out and a critical attitude toward his own work and the work of others. Gordon Floyd Ferris had all of these in generous measure.

GORDON FLOYD FERRIS, THE TEACHER

Ira L. Wiggins
Stanford University, Stanford, California

Gordon Floyd Ferris possessed a rare combination of talents, those of the highly productive research scientist, and at the same time a flair for, and a liking of, teaching that made him an exceedingly valuable member of three different departments during his 42 years of service at Stanford University. He began his career in teaching in the fall of the year in which he obtained his A.B. degree at Stanford, serving as a laboratory assistant in the Department of Entomology and Bionomics during the acedemic year of 1916-1917. Those who were his superiors in that department are long since gone, but there is little doubt that his performance in the laboratories during his year of work toward the Master's degree was not only satisfactory but well above average, for he was appointed to an instructorship in the Department of Entomology and Bionomics in the autumn of 1917, and served in that capacity until the end of the academic year of 1920–21. During that four year period he was engaged in supervising the laboratory work in the beginning courses in Entomology, with comparatively little opportunity to deliver lectures, that duty being performed by Vernon Kellogg, Professor Rene Doane and other members in the department senior to the young Ferris.

Perhaps it was this initial term of close contact with the students, working with first one and then another on an individual basis as problems in the laboratory were discussed and debated, that gave Gordon Ferris the foundation for such effective work in dealing with his students on a totally informal, person to person basis later in his career. During World War I and for several years immediately afterward, classes in the biological sciences were smaller than now, so one might expect that laboratory sections were then smaller and handled on a more leisurely basis than they are at present, but that assumption is not warranted. There were times when Ferris had supervision of 30 to 35 students in a beginning laboratory and many days found him still in the laboratory at six in the evening, helping the slower students complete their assignments. There were times when he resented the extra effort required, the time taken from the research problems on which he himself was engaged, but he did not shirk his duties

and responsibilities toward the young people in his laboratories. He did comment pungently on the situation at times, however. That he found time for a goodly amount of research is attested by the list of published papers appearing during those early years of his academic endeavors, and by the fact that he completed all requirements for the Master of Arts degree in the spring of 1918.

Even at that time Ferris was developing some of the traits that were to set him apart as an independent and courageous thinker, for he disagreed with two or three other members of the Zoology Department, with which Entomology was merged in 1921. The present writer was first introduced to the Stanford campus and its personnel in the autumn of 1924, three years after Gordon Ferris had been promoted to an Assistant Professorship, but even at that time the students in the departments of Botany and of Zoology (then two separate departments) told their colleagues with great glee the manner in which Ferris stuck to his own viewpoints on controversial subjects and argued vigorously, and usually successfully, with some of his colleagues.

The basis for much of his popularity with the students was the breadth and variety of his reading. He kept up with the literature in entomology to a remarkable degree, and missed little in a number of journals in other fields of zoology as well. This ability to keep his ideas and his arguments up to the minute served him well in his classes, for he quoted from the current research papers, brought new ideas to the laboratory, and discussed many of these papers frankly, often critcially with the students. He was, neither then nor later, at all hesitant about approaching a particular paper critically and objectively. If it seemed to him to be well written, based on sound investigative work, and accurate in its conclusion, he praised it; if he detected carelessness or unsupported statements, he quickly pointed to the defects and many times made constructive suggestions for overcoming the deficiencies apparent to him.

Nor was he content to teach his courses, do his laboratory research, and read widely in scientific and non-scientific fields. He spent weeks and months in the field, collecting insects of many kinds, but principally scale insects and lice, for he began to specialize in these two major groups comparatively early in his career. Early in the 1920s he made huge collections of both lice and scale insects in México, walking many long weary miles with his meager field equipment packed on one burro and accompanied

by a timid peon often greatly in fear of his life from "bandits" or "tigers." After each such field trip his lectures and his discussions during laboratory sessions were enriched by his experiences in such a way that the students gained a broader, deeper interest in entomology than they would had he confined his remarks to elaborations of the text or matter-of-fact consideration of dissections or drawings of various types of arthropods. Often he could associate a particular species of insect with a precise spot where it, or a close relative, had been encountered in the field. By bringing this type of personal touch into the classroom he enlivened and vitalized the subject for the students, often leading members of a class to elect entomology as a college major without suggesting such a course verbally.

It would be a mistake to assume that because Ferris kept members of his classes intensely interested in the subject that he was an easy taskmaster. He required conscientious work, close attention to detail, and a high degree of accomplishment in executing drawings or preparing insects for insertion into a collection. He was an excellent draftsman and experimented extensively with techniques for depicting insects accurately and yet with a minimum of time and effort. He was among the first to admit that all students were not equal in ability with a pencil or an inking pen, so did not insist that each acquire excellency as a draftsman, but he did insist that every member of his class could and should learn to make recognizable drawings that were accurate as to outline and scale. He was incensed by carelessness and by "fuzzy thinking." He wanted, and obtained, reasonably clear-cut English in examination papers and written reports if those exercises were to obtain good grades or his support when a candidate was seeking a position. He held high standards for his own professional achievement, and expected each student to strive diligently and constantly for improvement—not necessarily for perfection. He was well aware that the latter goal is rarely—if ever—attained.

He served as Assistant Professor from 1921 until 1927, and became Associate Professor with the beginning of the academic year of 1927-28. He remained at that grade for ten years, and was promoted to a full professorship in 1937. During all of these years his teaching activities claimed approximately one-half of his time, or during some years, more than that proportion of each working week. He taught general entomology, a course in histology and

microtechnique for several years, classification of insects, a specialized course on aphids, one on economic entomology with special emphasis on Coccidae, principles of nomenclature, and year after year supervised the advanced training of several graduate students working toward the Masters or Ph.D. degrees. He was a cooperative member of the department, and when the departments of Botany and Zoology were merged in 1934, and together with the course in General Biology constituted the Department of Biological Sciences, he accepted greater responsibility for course work in Entomology, and took over supervision of several sections of the General Biology laboratories.

With the passing of the years his penchant for philosophical contemplation of biology and biological activities increased and he developed advanced courses in the principles of classification, turned his attention to the internal anatomy of insects with the conviction that such studies could help solve some of the problems involved in the evolution of insects and provide stimulating teaching material. When other members of the department accepted appointments elsewhere and temporarily left the Department of Biological Sciences short of offerings in elective courses for upper division students, he accepted the responsibility for keeping such offerings available. In one such situation he developed a course in the philosophy and developments of the concepts associated with evolution and was pleased greatly that it gained a high degree of popularity, was greatly chagrined when his failing health necessitated its termination.

When Professor Doane retired and Ferris was the sole remaining entomologist in the Department of Biological Sciences, he accepted even heavier teaching burdens by giving some courses in alternate years, by reducing the time he could spend on his own research, and by almost eliminating recreational activities in the field of yachting and serving as a leader of a Sea Scout Ship. Thus, with the flight of time his teaching activities took a larger proportion of his time, his thought, and his energy, but these inroads on his time for research and extracurricular activities prompted very little protesting and no serious grumbling on his part. He saw the need for courses for the training of biology majors in certain aspects of entomology, and he filled those needs in a wholehearted, public-spirited manner.

Among the courses he gave after Doane's retirement was the

one Professor Doane had taught for a number of years in economic entomology, entitled, "Insects and Man" and known among the students as "Bugs and Bites" after Ferris assumed responsibility for it. No doubt his personal interest in the biting and sucking lice led him to emphasize the importance of these ectoparasites and partially set the tenor of the course. Be that as it may, the course was one of the more popular elective courses offered within the Department of Biological Sciences, despite the fact that it was a lecture course and one that required considerable reading from sources outside the text. He organized the material presented in such a way that the course could be taken without prerequisites, and many students at Stanford University had little or no other contact with college biology courses. To Ferris this placed a heavy responsibility on his shoulders, and he insisted on giving the course for several years after his health had begun to fail, and when the thrice-each-week lectures exacted a tremendous toll of his strength. Nor was this course considered a "pipe" by the students who elected it. Rather, they recognized it as an opportunity to become acquainted with a great teacher who, incidentally to them, was interested primarily in insects.

In this course as well as in his advanced ones, he drew from his rich experience while doing field work as a Guggenheim Fellow in México during 1925–26, a year spent at the Molteno Institute in England in 1930 and 1931, while on an extended expedition into Lower California and Panama in 1938; and late in his teaching career, from nearly a year spent in China as a Fulbright Fellow in 1948-49. When he described the malarial menace in the tropics, he had personal knowledge of the disease and its vectors, for he had suffered severly from malaria after his Mexican Trip in 1926. He had seen natives of several countries existing under the burdens of numerous ecto- and endoparasites and gave graphic and accurate word pictures of his observations. Apparently, Gordon Ferris saw little in the world of insects that he was unable to utilize in his teaching.

One of the striking characteristics of many of his lectures was the absence of notes when he confronted his classes. His ability to organize such a tremendous amount of information in his mind, and present it logically, interestingly, and with a personal slant without notes was a constant stimulus and source of admiration among his students. Not that he was oratorical in his presentation

—he was not. He presented the subject informally, in a rather high-pitched voice, but with such obvious personal interest in what he had to share, that his listeners remembered what he said long after they would have forgotten flights of rhetoric. Ferris did, however, have the ability to coin apt phrases that caught the attention of his audience and helped to impress them with the worth of his offerings. Perhaps, though, the greatest advantage he possessed was the ability to make his students or the members of an audience feel that they were sharing his experiences and his enthusiasm with him.

Important as his contributions to the intellectual life of the undergraduates who took his courses in entomology or related subjects were, his greatest service in teaching was among his own and other faculty members' graduate students. His technique in handling such instruction was almost wholly that of the informal conference. During such conferences he usually smoked incessantly, lighting one cigarette from the butt of the previous one. The student often had to supply the match with which to light the first one, and not infrequently, the subsequent cigarettes. The conference might last ten minutes, or it could continue for hours. Many, many times the discussion involving the student's research work, his problems in other courses, or general philosophical questions with numerous ramifications, would be interrupted long enough for them to drive to the Ferris home where the discussion could continue through the evening meal and well into the night. On such occasions the student was made to feel at ease and was given encouragement if that seemed to be called for. He could be, and sometimes was, subjected to rigorous verbal chastisement. But always he was urged to think his own thoughts, to approach every question as objectively as possible, and to keep an open, independent mind.

Several times each day Ferris would lay aside his pencil, his pen, or his dissecting needles, stroll into the cubicle of one of the graduate students, chat with him for a few minutes about the work that the student was doing or about a particular research project in which Ferris himself was engaged. These little interchanges, totally unscheduled and delightfully informal served to keep the graduate students aware of Ferris' work as well as to stimulate them to extended efforts toward solving their own problems. One of the results of such a practice was that many students who

would otherwise have become discouraged and dropped out of the struggle toward an advanced degree, continued on to either the Masters or Doctors degree—and some to both. He did not pamper his students, but he brought out their better qualities, often helped them find unexpected capacities, and won their life-long loyalty and respect.

Particularly during the years following World War II, candidates for the Ph.D. degree were encountering difficulties in passing the language examinations. Ferris decided that much of this difficulty stemmed from the lack of concerted, continuous effort toward really understanding the language involved, and in lack of practice in reading papers in a foreign tongue. To remedy the situation he organized a seminar in the reading of scientific German. For nearly ten years he met with any and all graduate students interested in biology who needed practice in reading German, but who could not arrange their schedules so as to take regular courses offered in the Department of Germanic and Romanic Languages. He spent from two to four hours per week in this service. He was not obliged to carry this burden, nor did he receive compensation for the time and effort expended. He received great satisfaction, however, from the knowledge that shortly after this seminar was instituted, there was a marked increase in the number of candidates who passed the examination in reading German—given by another member of the Department—on the first trial. Throughout the period of this seminar the often mentioned but seldom practiced scheme of running a university by having the "student on one end of the log and the professor on the other" was followed, for Ferris and the members of his seminar group tackled each reading assignment together, puzzled over German syntax and idioms, and struggled with complex German sentences. On rare occasions they had to consult a member of the instructional staff in German, but as time passed such consultations became less and less frequent, for Ferris' own command of the language improved with the repeated seminar sessions. This seminar, like his informal chats with candidates for advanced degrees, gave encouraging aid to a number of students who otherwise might have abandoned their efforts to secure training beyond the A.B. and kept them striving until the goal was finally attained. He can be credited personally with having applied the stimulus and the aid necessary to carry several students through

to one or the other of the advanced degrees so necessary for their professional improvement.

The full extent of Gordon Ferris' influence on modern entomology and contemporary entomologists is difficult to estimate. Some indication of the esteem in which his colleagues held him and his work is found in letters from workers living in many parts of the world. Many of them asked for professional advice or for opinions bearing on the writer's entomological problems. Their general spirit is that of men who recognized Ferris as an authority in his field, one whom they respected and whose opinions they could trust.

Another key to the scope of his influence is reflected in the number of graduate students who worked with him toward M.A. and Ph.D. degrees. Forty-five of his candidates successfully met the requirements for the M.A. and at least 19 individuals earned the Ph.D. under his supervision. The late P. N. (Perk) Annand, for a number of years Chief of the U. S. Bureau of Entomology and Plant Quarantine, was the first Stanford student to complete the requirements for the Ph.D. degree under Ferris' direction.

Among the other men and women who have obtained advanced degrees with Ferris' guidance, some have continued in teaching and research in various colleges and universities, some have found employment with state and federal agencies, a number entered teaching positions in high schools and junior colleges, a few have accepted positions involving applied entomolgy or basic research with industrial concerns. Their impact on entomology and entomologists continues the philosophy and spirit of independence that Gordon Ferris so ably represented.

Still another group of scholars entered Ferris' laboratory for specialized or advanced training and experience. Entomologists who had previously obtained advanced degrees came from various parts of the United States and from abroad to work with him; to learn at first hand his techniques in preparing and illustrating insects; to collaborate with him in particular research problems or to absorb the highly regarded brand of tolerance, and paradoxically some of the intolerances, that characterized the atmosphere in his laboratory and in his classrooms. Ferris himself would probably have been one of the first to disclaim any idea that he had a "mission" to teach these visitors anything special, or even that he felt he was teaching many of them anything at all. He

just gave each of them generously of his time and an opportunity to discuss many subjects during the course of the days spent with him. Each became, for varying periods, a guest in his home. To many of them the social hours there were as much of an education as were the days spent in the laboratory and in the field collecting specimens. Thus, Ferris came to know and respect entomologists scattered through many parts of the world, and they, in turn, highly regarded him. For years he kept up a terse correspondence with scores of them, and through this correspondence, liberally larded with flashes of beautiful phraseology, continued his influence in the field of entomology.

Ferris experimented with numerous approaches and methods in carrying on his teaching activities. Discussion in small groups was his forte but was by no means the only teaching technique he mastered. He assigned specific problems to individuals or to small groups in connection with laboratory courses, or placed material in the laboratory with general instructions to find out as much as possible by observing the organisms provided. Such an assignment did not mean neglect during several laboratory periods; rather, frequent but brief inspections of progress were made, with hints—rarely more than hints—about promising lines of attack or sources of information. His ability to keep in mind the respective tasks assigned to different members of a class, and his facility in picking up or temporarily dropping his own research at these frequent interruptions permitted him to accomplish large tasks under conditions that would have appalled many who demand protracted periods of uninterrupted concentration in order to get anything done. The knowledge that he was doing important research at the same time he was conducting his classes gave him stature in the eyes of the students, so he was held in high repute by them, equally as a research scientist and as an outstanding teacher.

In one of his advanced courses particularly, that in the Philosophy of Biology, Gordon Ferris utilized a technique that brought to his audience not only his own philosophy but laid behind it a background of the thinking and writing of many others. During part of almost every class period he would read aloud from the writings of both modern and older biologists until he had covered a particular point or series of ideas, then spend the time remaining to expound his own views about the passage read. In that way

he presented each "lecture" with a freshness of outlook and full familiarity with the subject that was most stimulating to the class.

A streak of impishness that came to the surface at unexpected times was a source of amusement to many and of embarrassment to others when they were the object of his teasing. Those with a well developed sense of humor usually could detect the approach of one of his sly digs or near-shocking comments, but to the overly serious or the person who sees little of humor if he is the butt of a joke, these incidents were always a surprise. He used the Theory of Evolution to lampoon pomposity by referring to the comparatively few generations that separate men from monkeys. From time to time he expressed skepticism about the immaculate conception or other aspects of Christian theology. Such deprecating statements were more often than not delivered when some member of a religious order was present in his class. At first such individuals were genuinely shocked and at times outraged, but usually more prolonged acquaintance with the man and his deep human sympathy revealed that his chief object was not to destroy another's faith, but only an effort to get his students to think for themselves and to approach questions objectively and open-mindedly.

Ferris believed that every human individual should be himself, think his own thoughts, find his own satisfactions in such manner as to do so without violating the dignity and rights of others, and determine his own philosophy and mode of life. He did not encourage conformity for the mere sake of conforming. He did not favor mediocrity through compliance of all members of society to the "norm" of that society. Often he astonished students seeking advice by hearing only part of the details of a tangled situation and then telling the man or woman to think out what he or she thought was the right thing to do and then go do it, regardless of what others might think. One may consider this type of advice dangerous, but he did not—provided one always tried to avoid harming another individual in the exercise of his own freedom. He advocated direct action, although not violent action. He managed to bring so much of his personal philosophy and convictions into his lectures and the discussions he held with smaller groups that no one could justly accuse him of neglecting the humanistic side of his science or his obligations as a citizen in his community.

Even in the discharge of his duties as a citizen he continued to teach effectively and apparently effortlessly. For a number of

years he was active with the Sea Scouts, and every Scout in his Ship learned a great deal about navigation, the rules of the sea, small boat handling and repairs, and other phases of Sea Scouting. But they also learned much about human relations, the place of the individual in the community, self-reliance, and numerous other traits and attributes of an American citizen. At one time he had the son of a city official and one of a Chinese restaurant proprietor in his Ship. The offspring of the city official had a bullying streak that did little to endear him to his associates. After being the subject of much heckling from the other, the Chinese boy turned on his tormentor and with a totally unexpected ferocity gave him a thorough trouncing. Ferris had seen the direction the squabble was taking and conveniently had an errand to perform elsewhere just before the argument reached the physical combat stage.

Obviously, his lessons were by no means confined to the classroom or the laboratory, and those dealing with Entomology were only a part of his genuine contribution to the total fund of knowledge obtained by the men and women, the boys and girls, with whom he lived and worked. Others might advocate teaching school children the art of getting along together, of social adjustment, even if the subject matter of scholastic endeavor were neglected, but not Ferris. He believed that sound study habits and a solid core of fundamental factual knowledge came first, that the social graces, if they were to be learned at all, should be learned at places other than in the classroom. Some of the "social graces" impressed him not one whit, although there was no more gracious host or companion within the membership of his department. He practiced what he preached in that he lived his own life according to his own lights and beliefs. He tried to avoid infringing on the rights of others while following his own modes of living, but he reserved unto himself the right to determine what his line of actions should be.

Gordon Ferris was so intensely aware of his obligation as a teacher that he made personal sacrifices that seemed, to some of his friends, unreasonable. For example, he took sabbatical leave only three times during the 42 years he served on the teaching and research staff of Stanford University, once to do arduous field work in México, once to spend a year at the Molteno Institute (in 1930-31-) in England, and once to spend nearly a year (1948-49) under a Fulbright Fellowship in China. Summer after

summer, when he was under no legal or moral obligation to remain on campus he spent practically every week day in his office-laboratory in order to be available to graduate students trying to complete requirements for advanced degrees. He received no additional remuneration nor academic preferment from such extra services, but was content to know that his students were benefitting from his presence. He refused to accept a flattering fellowship which would have permitted him to do field work and research simply because he felt obligated to teach his courses.

That such generous devotion to other's needs made deep impressions on the students whom he helped and befriended has been attested by scores of letters addressed to Mrs. Ferris, to other graduate students, and to the writer of this paper after the news of his death had been circulated. Typical of the eulogistic, but wholly sincere tributes are a few that read "To me Ferry's value as a teacher was not so much in the field of didactic instruction but rather as a living example. He lived in strict accordance with his principles. He was intellectually honest. He was honest with himself, his colleagues, and his students." Another writes: "I have been, and always will be, proud to be known as one of Professor Ferris' students." From another: "It has been said that the influence of a teacher never ends. In my courses in biology, Ferry will always be the most important influence. In the day-to-day practice of biology, things he said long ago, continue to guide me. Ferry had a strong and infectious spirit of radicalism about scientific 'authority' that I hope I never let down." And from a student whose major interests were in a segment of biology quite removed from entomology came this: "You must know that your loss is shared by every student who has worked in the Museum . . . I regarded Professor Ferris as a personal friend. He helped me many times with problems in my work and what was much more important, he was interested in what I was doing and what I was thinking . . . I took two formal courses from Professor Ferris . . . in which he didn't teach us about insects, but instead taught us to observe, to accurately record our observations and to trust nature, not books." Finally, another student wrote: " . . . please remember that the instructions he gave at the University and his spirit as a scientist may survive at least in one of his students. After all, Professor Ferris was the greatest teacher for me."

GORDON FLOYD FERRIS AS A STUDENT OF THE SCALE INSECTS

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The passing of Gordon Floyd Ferris on May 21, 1958, brought to a close the career of one of the most versatile Coccidologists of our time. It is evident that the things which can be properly said about Professor Ferris with respect to his work on scale insects involve the man and his approach to entomology rather than any special relationship with coccids as a group. He approached anything he undertook with a singleness of purpose, and an energy drive that was probably unmatched in any other entomologist I have ever known, and he worked with marked efficiency on any group which kindled his interest. In the scale insects he was productive in describing new taxonomic units, and in developing and publishing new terminology and new ideas about their morphology and classification. It is generally felt that most of his work on scale insects will stand indefinitely, though some of his proposals on the classification will doubtless be modified as new forms are discovered and others are studied more critcally.

Professor Ferris helped and encouraged many contemporary and younger workers, both in this country and abroad, a few of which include A. S. Balachowsky, G. De Lotto, W. J. Hall, Raymond Mamet, V. P. Rao, J. B. Steinweden, D. J. Williams, and the writer. In this respect he was most generous and hospitable in receiving fellow scientists into his laboratory and home in Palo Alto, making available his collection and library, and in lending valuable specimens for study. His uppermost thought was sharing his findings to advance the scientific knowledge of Coccoidea. His correspondence was world-wide, and he remained in touch with Coccidologists in many countries by prompt and generous exchange of specimens and helpful notations.

The attitudes of several foreign workers on scale insects about Profesor Ferris are abstracted as follows from certain letters received after his death.

D. J. Williams, London, England, May 28, 1958:

> I remember his welcome help when I first took up the study of the Coccoidea and since then he has given every assistance which, I understand, was his way with everyone.

His works have always been a source of encouragement and his wit often enlivened our subject. We will, no doubt, remember that he made life easier for us and that he has set us a standard which we feel bound to try and follow.

I am sorry that I never met him, but to you it will be a great personal loss.

Raymont Mamet, Mauritius Island, Indian Ocean, June 2, 1958:

The work of Professor Ferris on the Coccoidea and other insects will last for very many decades and we who have known him will always remember his simple and kind manners.

A. S. Balachowsky, Paris, France, June 2, 1958:

I was extremely pained to know that Dr. Ferris died from his heart disease May 21 last. It was a very great loss for the world's science. He was the most famous coccidologist of any time. He had had a very strong and original personality and contributed to establish coccidology on a modern level.

W. J. Hall, London, England, May 28, 1958:

His loss will be deeply felt by entomologists the whole world over and in particular by Coccidologists. No one has done more to advance our knowledge of the Coccids than Professor Ferris, and his work in this field will remain a tribute to his memory for many years to come. But he also made great contributions to other aspects of the subject, and by his passing we have lost an outstanding entomologist of world-wide repute.

Something should be said about Professor Ferris' ideas on scientific illustration or, as he preferred to call it, "entomological drafting." He felt that the average worker should content himself with good draftsmanship. That is, to record with severely simple means, and with utmost accuracy, what he sees. In Professor Ferris' opinion, there is no excuse for sloppiness in entomological illustration. He believed that accuracy and exquisite care are essential in entomology as in the field of mechanical design.

One of the most practical compromises he made in coccid delineation was that of the divided drawing which shows one half of the dorsal and one half of the ventral side of the insect. Such drawings are possible because these insects are bilaterally symmetrical. Even though divided drawings were used as early as 1904 by J. G. Sanders, in his work on Coccidae of Ohio, I., we can credit Professor Ferris with a considerable role in applying the method, not only to the Coccoidea but also to a number of other insect groups. He developed this technique to its present

state of outstanding utility, including the precision of detail demanded by the highest standards of work. Professor Ferris' brilliantly executed illustrations have gained for him the unquestioned reputation of being the world's foremost illustrator of Coccoidea.

The first publication of Professor Ferris on scale insects was done in 1916, as a junior author, with Professor R. W. Doane. It included the descriptions of three new species of Samoan scale insects, and the excellence of Ferris' drawings of these insects will be noted in this first article.

In 1918, he produced his first rather extensive paper on Coccoidea, "The California Species of Mealybugs," published in the Leland Stanford Junior University Publications, University Series.

The period from 1918–1935 was marked by the publication of a wide variety of papers on scale insects, among which were a series of 11 articles on "Notes on Coccidae (Hemiptera)" appearing in various numbers of the Canadian Entomologist. During this period other of his outstanding papers on scale insects appeared mostly in the Stanford University Publications, University Series, Biological Sciences, and several book reviews on scale insect works by other authors were published in certain numbers of Canadian Entomologist and Entomological News.

During 1936, and until the time of his death, Professor Ferris made tremendous strides in developing the taxonomy of Coccoidea.

The publication "*Microentomology*" was founded by him in 1935, and, as has already been pointed out by Dr. Ira Wiggins in a Memorial Number of that same Journal (vol. 23, pt. 2, p. 71, 1958), he "edited each number, contributed many important papers to its pages, and, more frequently than he really could afford, gave financial support to insure its publication."

Many issues of *Microentomology* were devoted to clarification of generic types, particularly of the armored scale insects (Diaspididae). In this regard, Professor Ferris records the following in one of the earlier issues of this journal:

> It is sufficient to say that the student of the Coccoidea is presented with two alternatives. On the one hand he may cling to the admittedly inadequate system of an earlier day and on the other he is forced to wander in a maze of generic names the application of most of which can not be determined from the existing literature. We are thus at the moment in something of an impasse in the study

> of this group. But the way of escape is evident, though laborious. The first step is to examine critically and illustrate adequately the types of the named genera so that students may have some basis for forming their own conclusions as to the characters which are available for the recognition of generic groups.

This he did in his inimitable manner, and these works have been the basis for critical world-wide revisions of many of these scale groups.

Less than a year before his death, Professor Ferris published in *Microentomology*, "A Brief History of the Study of the Coccoidea." His comments regarding certain workers on scale insects are quite critical, although justifiably so. The introduction expresses his feelings regarding the high quality work he believed necessary in Coccoidea taxonomic research. He comments:

> The author can quite truthfully say "much of this I saw and some of it I was." In writing this history toward the end of his life when there is no longer anything to be gained by undue avoidance of objectivity or of undue consideration for the feelings of others, the writer feels it incumbent upon him to express the truth as he feels it to be. Such truth requires a severe judgment upon various men who have been in the past or still are his colleagues. His estimates of the work done by some of his predecessors, and even by some of his colleagues is extremely unfavorable, but they are estimates made as honestly and sincerely as possible. For that he beg's no one's pardon.

Perhaps the most outstanding contribution on scale insect taxonomy which the world has ever known, is his monumental treatise entitled "Atlas of the Scale Insects of North America." The first four volumes of this Atlas, published during 1937–1942, were devoted to a comprehensive treatment of some 245 species of armored scale insects (Diaspididae), all of which were magnificently illustrated by Professor Ferris. Volumes V and VI of the Atlas, published in 1950 and 1953 respectively, included the systematics of the mealybugs (Pseudococcidae) of North America. In these two volumes 206 species and 38 genera of mealybugs were considered, and beautifully delineated by Professor Ferris. Volume VII of the Atlas, published in 1955, dealt with the Coccoidea families, Aclerdidae, Asterolecaniidae, Conchaspididae, Dactylopiidae, and Lacciferidae. In this volume taxonomic treatments for 168 coccids in 21 genera, together with keys to all, were presented.

BIBLIOGRAPHY OF GORDON F. FERRIS

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A bibliography of the scientific papers of the late Gordon F. Ferris appeared in *Microentomology*, Volume 23, Part 2, pages 75–80; September 26, 1958. The present one adds some titles; nearly all have been checked with the original sources. Attention was paid to the actual dates of publication whenever they could be verified, and some changes in the sequence of titles have resulted.

I am indebted to Dr. Ira Wiggins and Dr. Laura Henry for supplying me with lists of most of the papers by G. F. Ferris.

It is difficult to know how to list the numerous cases in which Professor Ferris' (paraphrased?) remarks at meetings of the Pacific Coast Entomological Society appear in the published Minutes. There is hardly a doubt that the information therein should be attributed to him, rather than to the persons who recorded and signed the minutes, and I am sure the recorders would have been the first to agree to this. Since all appeared as untitled notes in The Proceedings of the Society, they are given below as a unit, with my explanatory comments in brackets.

It should be noted that some of the Minutes which concern us (those of the 71st to 116th meetings) are in the two volumes of separately published Proceedings, and cannot be dated exactly. For details see the summary by J. W. MacSwain in the Pan-Pacific Entomologist for 1951 (27(3):105–109). The remainder are in the Proceedings, published annually in the Pan-Pacific Entomologist.

It is quite possible that Professor Ferris has been similarly reported in the minutes of other entomological societies, but there has not been an opportunity to make the necessary search.

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13. A note on the occurrence of abdominal spiracles in the Coccidae (Hemiptera). Canadian Entomologist, 50(3):85–88. Published March 15.
14. An apparently new species of Leptinillus (Coleoptera, Leptinidae). Canadian Entomologist, 50(4):125–128; figs. 4–6. Published April 13.

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28. A new species of Pseudodiaspis (Hemiptera; Coccidae).

Entomological News, 30(10):275–276; 1 fig. Published December 20.

1920

29. Contributions toward a monograph of the sucking lice. Part I. Leland Stanford Junior University Publications, University Series, Biological Sciences, 2(1):1–52 [p. 52 is blank]; figs. 1–32. Dated 1919, but actually published January 14, 1920.
30. Clarke nutcracker at sea. Condor, 22(1):39. Published January 26.
31. Notes on Coccidae—V (Hemiptera). Canadian Entomologist, 52(2)29–32; figs. 7–11. Published February 28.
32. The first stage larva of Cuterebra americana (Fabr.) (Diptera; Oestridae). Psyche, 27(1):13–14; fig. 1. February number.
33. Notes on Coccidae—VI (Hemiptera). Canadian Entomologist, 52(3):61–65; fig. 12. Published March 31.
34. Some records of Polyctenidae (Hemiptera). Journal of the New York Entomological Society, 27(4):261–263; pl. XXIV. Published April 17.
35. Scale insects of the Santa Cruz Peninsula. Stanford University Publicaitons, University Series, Biological Sciences, 1(1):1–57; figs. 1–35. (Received at the California Academy of Sciences Library on July 30.)
36. Insects of economic importance in the Cape Region of Lower California, Mexico. Journal of Economic Entomology, 13(6):463–467. December number.

1921

37. Notes on Coccidae—VII (Hemiptera). Canadian Entomologist, 53(3):57–61. Published April 4.
38. Review of "Monografia delle Cocciniglie Italiane." Entomological News, 32(5):157. Published May 3.
39. Notes on Coccidae—VIII (Hemiptera). Canadian Entomologist, 53(4):91–95. Published June 8.
40. Some Coccidae from eastern Asia. Bulletin of Entomological Research, 12(3):211–220; figs. 1–7. November number, published in September.
41. The Coccidae of Ceylon [*in re* funds for publication].

Science, (N.S.) 54 (1397) :330. Published October 7.
42. Contributions toward a monograph of the sucking lice. Part II. Stanford University Publications, University Series, Biological Sciences, 2(2) :53–134 [pp. 58 and 134 are blank]; figs. 33–89. Published October 14.
43. Report upon a collection of Coccidae from Lower California. Stanford University Publications, University Series, Biological Sciences, 1(2) :59–132; figs. 1–52. (Received at the California Academy of Sciences Library on November 18.)
44. A new species in the Hormaphidinae (Hemiptera, Aphididae). Entomological News, 32(10)289–291; pl. VI. Published December 16.

1922

45. Concerning lice. Journal of Mammalogy, 3(1) :16–18. Published February 8.
46. The mallophagan family Trimenoponidae. Parasitology, 14(1) :75–86; figs. 1–8. Published April 25.
47. (Senior author with F. R. Cole) A contribution to the knowledge of the Hippoboscidae (Diptera, Pupipara). Parasitology, 14(2) :178–205; figs. 1–20. Published June 15.
48. Review of "The Coccidae of Ceylon," by E. E. Green. Science, (N.S.) 56 (1446) :312–313. Published September 15.
49. Notes on Coccidae—IX (Hemiptera). Canadian Entomologist, 54(7) :156–161; figs. 1–4. Published October 12.
50. Contributions toward a monograph of the sucking lice. Part III. Stanford University Publications, University Series, Biological Sciences, 2(3) :135–138 [p. 138 is blank]; figs. 90–118. (Received at the California Academy of Sciences Library on October 19.)
51. A note on Timema californicum Scudder (Orthoptera; Phasmidae). Entomological News, 33(9) :282–283. Published November 3.
52. De anopluris. Scientific Monthly, 15(6) :551–556.
53. Two new Coccidae from Cyrenaica. Bollettino del Laboratorio di Zoologia generale e agraria della R. Scuola superiore d'Agricoltura in Portici, 16:207–210; figs. 1–2. This parti-

cular article was published on December 15.

54. Notes on Coccidae—X (Hemiptera). Canadian Entomologist, 55(11):246–248. Published December 30.

1923

55. Observations on the larvae of some Diptera Pupipara, with description of a new species of Hippoboscidae. Parasitology, 15(1):54–58; figs. 1–4. Published March 22.
56. (Senior author with Persis Hyatt) The life history of Euphyllura arbuti Schwarz (Hemiptera; Chermidae). Canadian Entomologist, 55(4):88–92; pl. 2. Published May 10.
57. The place of the systematist in modern biology. Scientific Monthly, 16(5):514–520. May number.
58. Mallophaga. *In*: Biological Survey of the Pribolof Islands, Alaska. North American Fauna, No. 46, Part II, p. 141. Published June 20.
59. (Senior author with J. B. Kelly) Some Coccidae from about the Gulf of California. Proceedings of the California Academy of Sciences (Fourth Series), 12(14):315–318; 1 fig. Published July 10.
60. Mallophaga. *In*: Report of the Scientific Results of the Norwegian Expedition to Novaya Zemlya 1921. 1(8):11–12. Published in July.
61. Entomological illustrations. Science, (N.S.) 58(1501):265–266. Published October 5.
62. Observations on the Chermidae (Hemiptera; Homoptera). Part I. Canadian Entomologist, 55(11):250–256; pl. 12, and text fig. 1. Published November 29.
63. Contributions toward a monograph of the sucking lice. Part IV. Stanford University Publications, University Series, Biological Sciences, 2(4):179–270; figs. 119–172. (Received at the California Academy of Sciences Library on January 4, 1924.)

1924

64. Two Diptera Pupipara from Philippine bats. Philippine Journal of Science, 24(1):73–79; figs. 1–3. Published January 22.
65. The mallophagan family Menoponidae. Part I. Parasitology, 16(1):55–66; figs. 1–5. Published January 31.

66. [General comments on the immature stages of the Psyllidae.] As quoted in the Minutes of the 87th meeting, Proceedings of the Pacific Coast Entomological Society, 2(2):24. Published January 31.
67. The study of minute insects. Canadian Entomologist, 56(2):25–28. Published February 29.
68. Report upon a collection of insect ectoparasites from Australian and Tasmanian mammals. (Diptera Pupipara. Siphonaptera). American Museum Novitates. No. 110:1–7; figs. 1–5. Published April 21.
69. The New World Nycteribiidae (Diptera Pupipara). Entomological News, 35(6):191–199; pl. 3, and 1 text fig. Published June 4.
70. The nymphs of two species of Chermidae (Hemiptera). Pan-Pacific Entomologist, 1(1):24–28; figs. 1–2. Published June 25.
71. A note on some Hippoboscidae (Diptera Pupipara). Entomological News, 35(7):234–235. Published July 3.
72. Some Diptera Pupipara from the Philippine Islands. Philippine Journal of Science, 25(4):391–403 [p. 402 is blank]; figs. 1–7. Published November 17.

1925

73. Observations on the Chermidae (Hemiptera; Homoptera). Part II. Canadian Entomologist, 57(2):46–50; figs. 1–3. Published February 28.
74. On two species of the genus Halarachne (Acarina; Gamasidae). Parasitology, 17(2):163–167; figs. 1–2. Published May 18.
75. The content of systematic biology. Scientific Monthly, 20(6):653–658. June number.
76. Third report upon Diptera Pupipara from the Philippine Islands. Philippine Journal of Science, 27(3):413–421; figs. 1–5. Published August 3.
77. Notes on Coccidae—XI (Hemiptera). Canadian Entomologist, 57(9):228–234; figs. 1–4. Published September 26.
78. (with L. E. Myers) The generic types of the Diaspidae (Hemiptera). Bulletin of Entomological Research, 16(2): 163–167; pls. 12–13. Published in October.
79. Fourth report upon Diptera Pupipara from the Philippine

Islands. Philippine Journal of Science, 28(3):329–341 [p. 340 is blank]; figs. 1–5. Published November 6.

80. Systematic problems and work [a short general statement apparently quoted in full, in the Minutes of the 97th meeting]. Proceedings of the Pacific Coast Entomological Society, 2(4):59–60. Published afted mid-June, 1925 (see notes following this numbered biblography).

1926

81. The mallophagan family Menoponidae. Part II. Parasitology. 18(1):1–3; 1 fig. Published January 22.
82. Observations on the Chermidae (Hemiptera: Homoptera). Part III. Canadian Entomologist, 58(1):13–20; figs. 1–5. Published January 30.
83. Indians' Hair [congregations of Phalangida on tree trunks in Mexico.] Nature Magazine, 8(4):222; 1 fig. October number.
84. Report upon a collection of Hippoboscidae (Diptera Pupipara) from Borneo. Sarawak Museum Journal, 3 (Part III, No. 10):279–286; pl. 11 and text figs. 1–2. December number.

1927

85. (Senior author with E. W. Nissen) The larva of a species of the Cassididae (Coleoptera). Pan-Pacific Entomologist, 3(4):169–172; 1 fig. Published June 9.
86. The generic types of the Diaspidae (Hemiptera). (Introductory note to Part II). Bulletin of Entomological Research, 17(4):341. Published in June.
87. Hippoboscidae. British Museum (Natural History): Insects of Samoa, and other Samoan terrestrial Arthropoda. Part VI, Diptera; fascicle 1, pp. 10–21; figs. 1–6. Published July 23.
88. Mealybugs. Monthly Bulletin of the Department of Agriculture, State of California, 16(6):336–342. June number (received at the California Academy of Sciences Library on August 10.)
89. Some American Hippoboscidae (Diptera Pupipara). Canadian Entomologist, 59(10):246–251; figs. 1–4. Published in October.

90. Fifth report upon Diptera Pupipara from the Philippine Islands. Philippine Journal of Science, 34(2):207–233; figs. 1–19. Published November 9.
91. Notes on an entomological enigma. Canadian Entomologist, 59(12):279–281; 1 fig. Published December 11.

1928

92. The larva of Olfersia vulturis Van der Wulp. (Diptera: Hippoboscidae). Entomological News, 39(2):36–37; 1 fig. Published February 3.
93. The genus Myialges (Acarina: Sarcoptidae). Entomological News, 39(5):137–140; pl. III. Published May 3.
94. Observations on the Chermidae (Hemiptera: Homoptera). Part IV. Canadian Entomologist, 60(5):109–117; figs. 1–4. Published June 2.
95. The genus Brachypteromyia Williston (Diptera Pupipara; Hippoboscidae). Pan-Pacific Entomologist, 4(3):140–142; figs. 1–2. Published June 26.
96. (Senior author with J. C. Chamberlin) On the use of the word "Chitinized." Entomological News, 39(7):212–215. Published July 2.
97. The mallophagan family Menoponidae. Part III. Parasitology, 20(2):221–227: figs. 7–9. (Not seen by compiler.)
98. Observations on the Chermidae (Hemiptera: Homoptera). Part V. Canadian Entomologist, 60(10):240–245; figs. 1–3. Published October 29.
99. The principles of systematic entomology. Stanford University Publications, University Series, Biological Sciences, 5(3):101–270 [also separately paged 1–170; pp. 106, 108 and 270, or 6, 8 and 170 are blank], figs. 1–11. Published in December.
100. Review of "A Classification of the higher groups and genera of the coccid family Margarodidae," by H. Morrison. Entomological News, 39(10):325–327. Published December 17.
101. The wax-secreting organs of the Coccidae. Pan-Pacific Entomologist, 5(2):67–70. Published December 29.
102. Scientific exploration, a phantasy. Scientific Monthly, 27:537–541. December number.

1929

103. (Junior author with J. C. Chamberlin) On Liparocephalus and allied genera (Coleoptera; Staphylinidae). Pan-Pacific Entomologist, 5(3):137–143. Published April 18.
104. (Junior author with J. C. Chamberlin) On Liparocephalus and allied genera (Coleoptera; Staphylinidae). Pan-Pacific Entomologist, 5(4):153–162; figs. 1–5. (Continuation of previous item.) Published May 31.
105. Systematic biology and the mutation theory. Quarterly Review of Biology, 4(3):389–400. Published in September.
106. Concerning the Mediterranean fruit fly. Science, (N.S.) 70(1819):451–453. Published November 8.
107. Review of "A Manual of External Parasites," by H. E. Ewing. Entomological News, 40(10):337–341. Published December 19.

1930

108. Observations on the genus Ornithoica (Diptera: Hippoboscidae). Canadian Entomologist, 61(12):280–285; figs. 1–4. The December, 1929 number, but actually published on January 4, 1930.
109. The effectiveness of a plant quarantine. Science, (N.S.) 71(1829):68–69. Published January 17.
110. Some New World Hippoboscidae (Diptera Pupipara). Canadian Entomologist, 62(3):62–70; figs. 1–5. Published March 31.
111. The plant quarantines once more. Science, (N.S.) 71(1850): 606–607. Published June 13.
112. Some African Diptera Pupipara. Parasitology, 22(3):275–282; figs. 1–6. Published July 30.
113. The puparium of Basilia corynorhini (Ferris) (Diptera: Nycteribiidae). Entomological News, 41(9):295–297, 1 fig. Published November 7.
114. Report upon certain ectoparasites of mammals. *In*: Report of the Harvard-African Expedition upon the African Republic of Liberia and the Belgian Congo, 2:1022–1038; figs. 12–24. (Not seen by compiler.)
115. Plant quarantines run wild. New Republic, 63:335–338. (Not seen by compiler.)
116. Sixth report upon Diptera Pupipara from the Philippine

Islands. Philippine Journal of Science, 43(4)537–553; figs. 1–7. Published November 10.

1931

117. The louse of elephants. Haematomyzus elephantis Piaget (Mallophaga; Haematomyzidae). Parasitology, 23(1):112–127; text figs. 1–5, pls. 4–5. Published January 31.

1932

118. Contributions toward a monograph of the sucking lice. Part V. Stanford University Publications, University Series, Biological Sciences, 2(5):271–414 [p. 414 is blank; this item is also separately paged 1–143]; figs. 173–251. Published October 15.
119. New species and other records of Mallophaga from the Marquesas. B. P. Bishop Museum, Bulletin No. 98, pp. 53–72; figs. 8–20. (Marquesan Insects—I. Pacific Entomological Survey Publication I, article 5.)
120. Ectoparasites of Marquesan rats. B. P. Bishop Museum, Bulletin No. 98, pp. 117–127; figs. 35–39. (Pacific Entomological Survey Publication I, article 12.)
121. (With F. D. Klyver) Report upon a collection of Chermidae (Homoptera) from New Zealand. Transactions and Proceedings of the New Zealand Institute, 63(1):34–61; pls. 7–16. Published October 30.
122. Mallophaga from Tahiti. B. P. Bishop Museum, Bulletin No. 113, pp. 7–12; figs. 1–4. (Society Island Insects. Pacific Entomological Survey Publication 6, article 2.) Published December 23.

1933

123. A new species of Polyplax (Anoplura). Parasitology, 25(1):127–129; figs. 1–2. Published March 4.
124. The mallophagan genus Trichophilopterus. Parasitology, 25(4):468–471; figs. 1–2. Published December 7.
125. Contribution toward a monograph of the sucking lice. Part VI. Stanford University Publications, University Series, Biological Sciences, 2(6):415–470 [p. 418 is blank; this item is also separately paged 1–56]; figs. 253–276. Published December 15.

1934

126. Review of "The efficacy and economic effects of plant quarantines in California." Science, (N.S.) 79(2036):13–14. Published January 5.
127. A summary of the sucking lice. (Anoplura.) Entomological News, 45(3):70–74. Published March 9.
128. A summary of the sucking lice (Anoplura). Entomological News, 45(4):85–88. (Continuation of previous item.) Published April 10.
129. Contributions toward a monograph of the sucking lice. Part VII. Stanford University Publications, University Series, Biological Sciences, 2(7):471–526 [p. 474 is blank; this item is also separately paged 1–56]; figs. 277–305. Published June 1.
130. Setae. Canadian Entomologist, 66(7):145–150; 2 figs. Published August 31.

1935

131. The prothoracic pleurites of Coleoptera. Entomological News, 46(3):63–68; fig. 1. Published March 7.
132. The prothoracic pleurites of Coleoptera. Entomological News, 46(4);93–95. (Continuation of previous item.) Published April 3.
133. Scale insects (Hemiptera: Coccoidea) from the Marquesas. B. P. Bishop Museum, Bulletin No. 142, pp. 125–131. figs. 1–3. (Marquesas Insects—III. Pacific Entomological Survey, Publication 8, article 9.) Published May 29.
134. An apparently undescrbed mealybug (Hemiptera: Pseudococcidae) from Tahiti. B. P. Bishop Museum, Bulletin No. 142, pp. 133–135; fig. 1. (Marquesas Insects—III. Pacific Entomological Survey Publication 8, article 10.) Published May 29.
135. Contributions toward a monograph of the sucking lice. Part VIII. Stanford University Publications, University Series, Biological Sciences, 2(8):527–634 [also separately paged 1–108]; text figs. 306–338, pls. I–III, plus an Erratum slip relating to pls. I and II. Published July 2.

1936

136. Foreword [to the first issue of the new journal Micro-

entomology]. Microentomology, 1(1):1. Published January 27.

137. Contributions to the knowledge of the Coccoidea (Homoptera). Microentomology, 1(1):2–16; figs. 1–10. Published January 27.

138. (Senior author with Michael Doudoroff) Taxonomic problems in Lepidoptera. Entomological News, 47(5):124–128. Published May 8.

139. Review of "Bibliography of Australian Entomology 1775–1930 with bibliographical notes on authors and collectors" by A. Musgrave. Pan-Pacific Entomologist, 12(2):64. Published May 15.

140. Contributions to the knowledge of the Coccoidea (Homoptera). II. Microentomology, 1(2):17–92; figs. 11–74. Published May 22.

141. (Senior author with G. E. Murdock) Contributions to the knowledge of the Coccoidea (Homoptera). III. Microentomology, 1(4):115–122; figs. 83–85. Published December 9.

1937

142. Atlas of the scale insects of North America. Series 1, Numbers 1–136. Stanford University Press. (No page numbers, each Number to be considered as a separate publication.) Published in January.

143. Contributions to the knowledge of the Coccoidea (Homoptera). IV. Microentomology, 2(1):1–45; figs. 1–36. Published March 24.

144. On certain words used in connection with the Coccoidea (Homoptera). Entomological News, 48(5):141–143. Published May 13.

145. Contributions to the knowledge of the Coccoidea (Homoptera). V. Microentomology, 2(2):47–102; figs. 37–79. Published June 15.

146. Contributions to the knowledge of the Coccoidea (Homoptera). VI. Microentomology, 2(3):103–122; figs. 80–95. Published November 24.

147. On nomenclatorial and other problems in the systematics of the Coccoidea (Insecta: Homoptera). Annals and Maga-

zine of Natural History, (Tenth Series) 20(119):525–530. November number.

1938

148. Contributions to the knowledge of the Coccoidea (Homoptera). VII. Microentomology, 3(2):37–56; figs. 17–32. Published April 28.
149. Atlas of the scale insects of North America. Series 2, Numbers 137–268. Stanford University Press. (No page numbers, each Number to be considered as a separate publication.) Published in November.
150. Contributions to the knowledge of the Coccoidea (Homoptera). VIII. Microentomology, 3(3):57–75; figs. 32–44. Published December 10.
151. In forests of hair and feathers. Where insects live in virtual darkness and are adapted to their environment. Nature Magazine, 31(10):591–592, 1 fig. December number.

1939

152. Review of "The Genus Septobasidium. By John N. Couch." Entomological News, 49(10):297–298. Number for December, 1938, but not actually published until January 11, 1939.
153. (Senior author with R. L. Usinger) The family Polyctenidae (Hemiptera; Heteroptera). Microentomology, 4(1):1–50; figs. 1–25. Published February 21.
154. (Senior author with B. E. Rees) The morphology of Panorpa nuptialis Gerstaecker (Mecoptera: Panorpidae). Microentomology, 4(3):79–108; figs. 36–51. Published October 17.
155. (Senior author with P. Pennebaker) The morphology of Agulla adnixa (Hagen) (Neuroptera: Raphididae). Microentomology, 4(5):121–142; figs. 59–72. Published November 22.
156. (Junior author with B. E. Rees [and C. P. Alexander, see following]) The morphology of Tipula reesi Alexander (Diptera: Tipulidae). Microentomology, 4(6):143, 145–178 [the last part of p. 143 and all of p. 144 are by C. P. Alexander]; figs. 72–91. Published December 20.

1940

157. The morphology of Plega signata (Hagen) (Neuroptera:

Mantispidae). Microentomology, 5(2):33–56; figs. 6–20. Published May 15.

158. The myth of the thoracic sternites of insects. Microentomology, 5(3):87–90. Published June 4.

1941

159. Atlas of the scale insects of North America. Series 3, Numbers 269–384. Stanford University Press. (No page numbers, each Number to be considered as a separate publication.) Published March 27.
160. Contributions to the knowledge of the Coccoidea(Homoptera). IX. A forgotten genus of the family Margarodidae. Microentomology, 6(1):6-10; fig. 3. Published March 28.
161. Contributions to the knowledge of the Coccoidea (Homoptera). X. Illustration of eleven genotypes of the Diaspididae. Microentomology, 6(1):11–24; figs. 4–14. Published March 28.
162. Contributions to the knowledge of the Coccoidea(Homoptera). XI. A new genus in the Pseudococcidae (Homoptera; Coccoidea). Microentomology, 6(1):25–28; figs. 15–16. Published March 28.
163. A new species of Stomacoccus (Homoptera; Coccoidea; Margarodidae), Microentomology, 6(1):29–32; figs. 17–18. Published March 28.
164. The genus Aspidiotus (Homoptera; Coccoidea; Diaspididae). Microentomology, 6(2):33–70; figs. 19–26. Published November 28.

1942

165. (Senior author with E. G. Linsley and R. L. Usinger) An American Entomological Code. (In the Minutes of the 169th meeting, Proceedings of the Pacific Coast Entomological Society) *in*: Pan-Pacific Entomologist, 18(1):44–45. Published February 19.
166. Insect morphology and evolution. Abstract of an address for the Entomological Society of America. Proceedings of the Thirty-Sixth Annual Meeting, *in*: Annals of the Entomological Society of America, 35(1):114–116. Published April 2.
167. Atlas of the scale insects of North America. Series 4,

Number 385–448. Stanford University Press. (No page numbers, each Number to be considered as a separate publication.) Published May 28.

168. The needs of systematic entomology. Journal of Economic Entomology, 35(5):732–738. October number.
169. Observations on some ectoparasitic mites (Arachnida: Acarina: Dermanyssidae). Microentomology, 7(3):77-83; figs. 36–38. Published December 28.
170. Some North American, rodent-infesting lice (Insecta: Anoplura). Microentomology, 7(3):84–90; figs. 39–42. Published December 28.

1943

171. Some fundamental concepts in insect morphology. Microentomology, 8(1):2–7. Published May 6.
172. The basic materials of the insect cranium. Microentomology, 8(1):8–24; figs. 1–6. Published May 6.
173. Additions to the knowledge of the Diaspididae (Homoptera: Coccoidea). Microentomology, 8(2)58–79; figs. 24–32. Published September 22.
174. The genus Targionia Signoret and some of its allies (Homoptera: Coccoidea: Diaspididae). Microentomology, 8(3):81–111; figs. 33–43. Published December 30.

1944

175. On certain evolutionary tendencies in the heads of insects. Microentomology, 9(2):78–84; fig. 40. Published December 20.

1945

176. (Senior author with R. L. Usinger) Notes and descriptions of American Polyctenidae (Hemiptera). Pan-Pacific Entomologist, 21(4):121–124. Published November 26.

1946

177. Information concerning the genera Chortinaspis and Aspidiotus (Homoptera: Coccoidea: Diaspididae). Microentomology, 11(1):37–49; figs. 16–20. Published April 30.

1947

178. (Senior author with V. P. Rao) The genus Pinnaspis

Cockerell (Homoptera: Coccoidea: Diaspididae). Microentomology, 12(2):25–58; figs. 10–12. Published October 22.

179. The contradictions of the insect head. Microentomology, 12(3):59–64. Published November 10.

1948

180. The principles of comparative morphology. Microentomology, 13(3):49–56. Published September 15.

1949

181. (Senior author with L. M. Henry) The nervous system and a problem of homology in certain Crustacea (Crustacea: Copepoda: Caligidae). Microentomology, 14(4):113–118; figs. 66–67. Published December 20.

1950

182. Report upon scale insects collected in China (Homoptera: Coccoidea). Part I. Microentomology, 15(1):1–34; figs. 1–20. Published February 21.

183. Report upon scale insects collected in China (Homoptera: Coccoidea). Part II. Microentomology, 15(3):69–97; figs. 30–47. Published July 27.

184. A reply to criticism. Microentomology, 15(4):126–128. Published October 20.

185. Atlas of the scale insects of North America. Series 5, The Pseudococcidae. Part I. Stanford University Press, vii + 278 pp.; figs. 1–108. (Not seen by compiler.)

186. External morphology of the adult. Chapter 5, pp. 368–419 *in*: Demerec's "Biology of Drosophila." John Wiley and Sons, Inc., New York. (Not seen by compiler.)

1951

187. The sucking lice. Memoirs of the Pacific Coast Entomological Society, San Francisco. Memoir 1: x + 320 pp.; figs. 1–124. Published October 19.

1952

188. Some miscellaneous Coccoidea (Insecta: Homoptera). Microentomology, 17(1):2–5; figs. 1–2. Published February 8.

189. Report upon scale insects collected in China (Homoptera: Coccoidea). III. Microentomology, 17(1):6–16; figs. 3–9. Published February 8.
190. (Junior author with V. P. Rao) The genus Andaspis MacGillivray (Insecta: Homoptera: Coccoidea). Microentomology, 17(1):17–32; figs. 10–19. Published February 8.

1953

191. On the comparative morphology of the Annulata. A summing up. Microentomology, 18(1):2–15. Published January 1.
192. (Senior author with R. L. Usinger) A new species of Aphraniola from Cambodia [Hemiptera, Cimicidae]. Revue française d'Entomologie, 20(2):138–139. Published July 25.
193. Illustrations of three species of sucking lice, with notes on a fourth species (Insecta: Anoplura). Microentomology, 18(2):52–57; figs. 19–22. Published August 31.
194. Report upon scale insects collected in China (Homoptera: Coccoidea). Part IV. Microentomology, 18(3):59–84; figs. 23–39. Published September 22.
195. Atlas of the scale insects of North America. The Pseudococcidae. Part II. Volume VI. Stanford University Press, vii + pp. 279–506; figs. 109–193. (Not seen by compiler.)

1954

196. A new species of Anoplura. Annals of the Natal Museum, 13(1):91–94; 1 text fig. Published June 30.
197. New species of Diaspididae from Florida and the Caribbean Islands (Homoptera: Coccoidea). Microentomology, 19(2): 41–50; figs. 26–31. Published July 15.
198. Report upon scale insects collected in China (Homoptera: Coccoidea). Part V. Microentomology, 19(2):51–66; figs. 32–42. Published July 15.

1955

199. Atlas of the scale insects of North America. Volume VII. Stanford Univeristy Press, iii + 233 pp.; 94 figs. (Exact date not known to compiler.)
200. On some genera of the Pseudococcidae (Homoptera: Coccoidea). Microentomology, 20(1):1–19; figs. 1–13. Published January 28.

201. Some miscellaneous Coccoidea (Insecta: Homoptera). Microentomology, 20(2):21–29; figs. 14–17. Published April 15.
202. Report upon a collection of scale insects from China. VI. (Insecta: Homoptera). Microentomology, 20(2):30–40; figs. 18–24. Published April 15.
203. The genus Phenacaspis Cooley and Cockerell. Part I. (Insecta: Homoptera: Coccoidea). Microentomology, 20(3): 41–82; figs. 25–52. Published August 1.
204. The contribution of natural history to human progress. Pp. 75–87 *in*: A Century of Progress in the Natural Sciences, 1853–1953. Published in Celebration of the Centennial of The California Academy of Sciences. California Academy of Sciences, San Francisco. Published October 20.
205. Some minute insects: Anoplura, Mallophaga and the scale insects. Pp. 517–523 *in*: A Century of Progress in the Natural Sciences, 1853–1953. Published in Celebration of the Centennial of The California Academy of Sciences. California Academy of Sciences, San Francisco. Published October 20.

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206. The genus Phenacaspis Cooley and Cockerell. Part II. (Insecta: Homoptera: Coccoidea). Microentomology, 21(2):67–83; figs. 35–43. Published April 13.

1957

207. (Senior author with R. L. Usinger) Notes on and descriptions of Cimicidae (Hemiptera). Part I. Microentomology, 22(1):1–37; figs. 1–25. Published April 15.
208. Two species of Diaspididae new to the Hawaiian fauna (Homoptera: Coccoidea). Proceedings of the Hawaiian Entomological Society, 16(2):212–215; figs. 1–2. Published May 13.
209. (Senior author with R. L. Usinger) Hemiptera: Heteroptera: Cimicidae. South African Animal Life, 4:374–376; 1 fig. (Exact publication date not known to compiler.)
210. A brief history of the study of the Coccoidea. Microentomology, 22(2):39–57; fig. 26. Published July 1.
211. Notes on some little known genera of the Coccoidea (Homop-

tera). Microentomology, 22(3):59–79; figs. 27–38. Published September 4.

212. A review of the family Eriococcidae (Insecta: Coccoidea). Microentomology, 22(4):81–89; figs. 39–43. Published October 15.

1958

213. The nervous system of insects. Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. 1:469–472. Published in December.

214. The geographic distribution of the Coccoidea. [A short abstract only.] Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. 1:829. Published in December.

1959

215. (Senior author with R. L. Usinger) A new species of Stricticimex from Kenya (Hemiptera: Cimicidae). Annals of the Entomological Society of America, 52(1):81–82; figs. 1–2. Published in February.

216. (With R. L. Usinger) Heteroptera: Cimicidae. *In*: Insects of Micronesia. B. P. Bishop Museum. [In press.]

217. Sections Insecta, Mallophaga and Anoplura. *In*: Encyclopedia of Science and Technology. McGraw-Hill Book Co., Inc. [In press.]

Untitled Notes Presented in the Proceedings of the Pacific Coast Entomological Society

A. Appearing in the two separately published volumes of The Proceedings of the Pacific Coast Entomological Society and as reported in the Minutes of the meetings.

1919. [Reference to fleas on mountain beaver, and a polyctenid on bats] Proceedings of the Pacific Coast Entomological Society, 1: unnumbered page carrying the Minutes of the 71st meeting.

1920. [Comment on the scarcity of Lepidoptera and Odonata in Lower California during the summer of 1919.] *Loc. cit.*, 1: unnumbered page carrying the first part of the Minutes of the 74th meeting.

1922. [Very general note on the sucking lice.] Minutes of the

83rd meeting. *Loc. cit.*, 2(1):7. Published November 15.

1927? [Note on some California scale insects.] Minutes of the 106th meeting. *Loc. cit.*, 2(6):93. Published between late June, 1927 and the beginning of March, 1928.

1927? [Report on Mr. Meyers' studies on the parasitism of swallows by a species of Cimex.] Minutes of the 107th meeting. *Loc. cit.*, 2(7):97. Published between late June, 1927 and the beginning of March, 1928.

1928? [On the nymphs of the Psyllidae, and on the then-unidentified larva of the beetle Brachypsectra; see also *loc. cit.* p. 105.] Minutes of the 112th meeting. *Loc. cit.*, 2(7):109. Published between the beginning of May, 1928, and early February, 1929.

1929? [On the staphylinid beetle genus Liparocephalus.] Minutes of the 116th meeting. *Loc. cit.*, 2(8):121–122. Published between late April, 1929, and late January, 1930.

1929? [On the larva of Brachypsectra.] Minutes of the 116th meeting. *Loc. cit.*, 2(8):122. Published between late April, 1929, and late January, 1930.

B. Appearing in The Proceedings of the Pacific Coast Entomological Society, as published in The Pan-Pacific Entomologist, and as reported in the Minutes of the meetings.

1936. [General comments on the sucking lice.] Minutes of the 129th meeting. Proceedings of the Pacific Coast Entomological Society, *in*: The Pan-Pacific Entomologist, 11(4):186. This, the October, 1935 issue of the journal was published on January 10, 1936.

1938. [Announcing the preparation of an atlas of scale insects.] Minutes of the 145th meeting. *Loc. cit.*, 14(4):192. Published November 15, 1938.

1939. [Comment on the stability of species, with a definition.] Minutes of the 147th meeting. *Loc. cit.*, 15(1):46. Published February 10, 1939.

1940. [General remarks on a trip to Panama.] Minutes of the 153rd meeting. *Loc. cit.*, 16(1):39. Published February 17, 1940.

1940. [On the principles of geographic distribution.] Minutes of the 155th meeting. *Loc. cit.*, 16(1):42.

1940. [General note.] Minutes of the 158th meeting. *Loc. cit.*, 16(1):45.

1941. [General remarks.] Minutes of the 162nd meeting. *Loc. cit.*, 17(1):42. Published February 21, 1941.

1942. [Comment on ectoparasites.] Minutes of the 166th meeting. *Loc. cit.*, 18(1):40–41. Published February 19, 1942.

1943. [Movement for an American Commission on Scientific Nomenclature in Entomology.] Minutes of the 173rd meeting. *Loc. cit.*, 19(1):37. Published March 22, 1943.

1943. [More on the American Commission (see preceding item); comment on his Atlas of Scale Insects.] Minutes of the 175th meeting. *Loc. cit.*, 19(1):38, 39.

1946. [General comments on the mealybugs of North America.] Minutes of the 187th meeting. *Loc. cit.*, 22(1):36–37. Published March 29, 1946.

1946. [Labor-saving devices in entomological drawing.] Minutes of the 188th meeting. *Loc. cit.*, 22(1):39.

1948. [Resumé of an address on "The Mealybugs of North America."] Minutes of the 193rd meeting. *Loc. cit.*, 24(1):39–40. Published March 31, 1948.

1949. [A comment on Dr. Henry's work on the nervous system of the lower invertebrates, as relating to the hypopharynx of insects.] Minutes of the 199th meeting. *Loc. cit.*, 25(1):42. Published March 17, 1949.

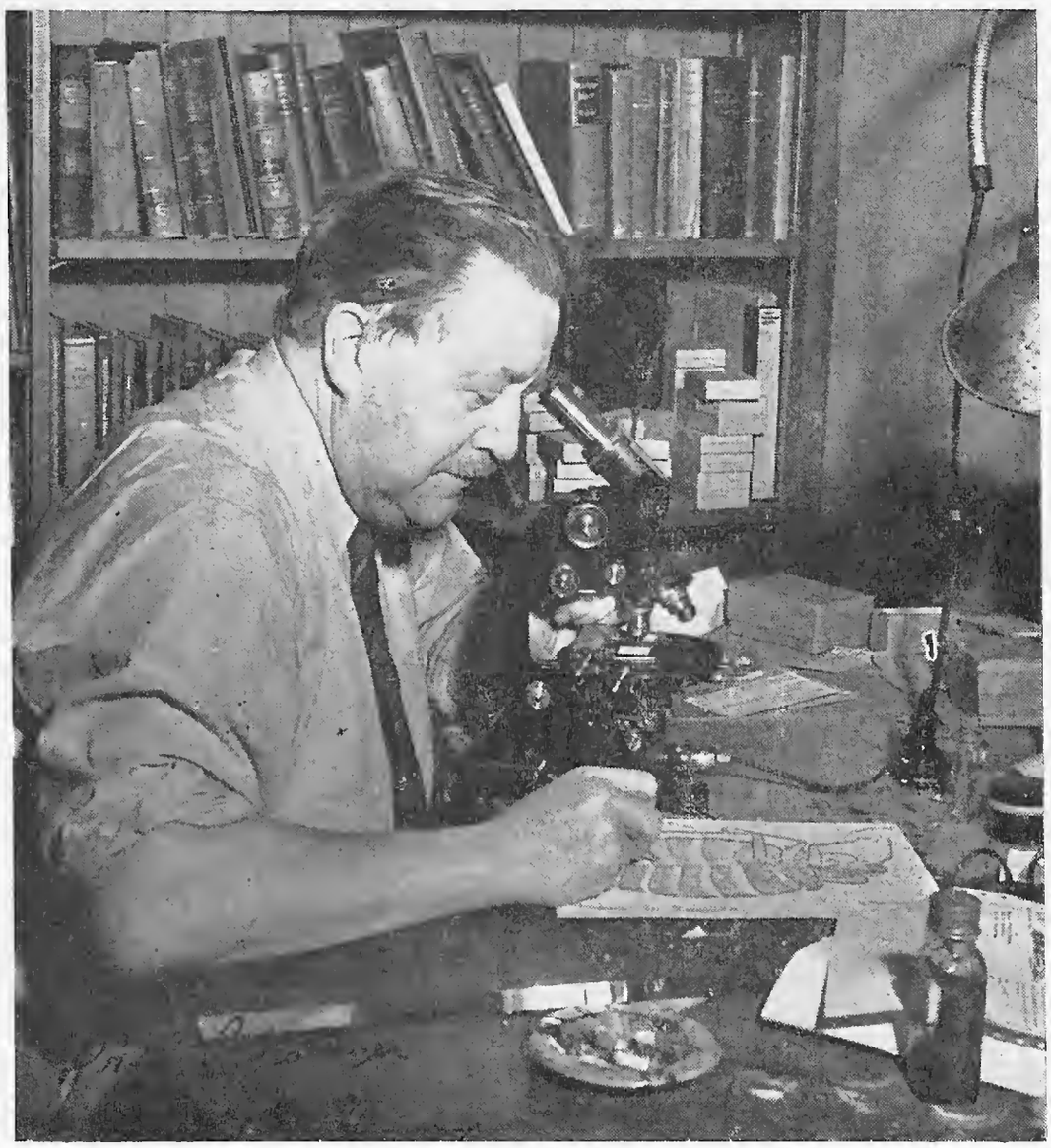
1953. [Comment on the principles of comparative morphology of arthropods.] Minutes of the 223rd meeting. *Loc. cit.*, 29(1):64. Published March 23, 1953.

1957. [Resumé of a talk on the family Margarodidae.] Minutes of the 247th meeting. *Loc. cit.*, 33(1):47. Published March 22, 1957.

1957. [Comment on the 10th International Congress of Entomology.] Minutes of the 250th meeting. *Loc. cit.*, 33(1):49.

PACIFIC COAST ENTOMOLOGICAL SOCIETY

R. L. Doutt	D. D. Jensen	D. P. Furman
Vice-President	*President*	*Secretary*



Gordon Floyd Ferris (1893 - 1958)

Proceedings

Two Hundred and Fifty-seventh Meeting

The two hundred and fifty-seventh meeting of the Pacific Coast Entomological Society was held February 14, 1958, at 7:40 p.m. in the Morrison Auditorium, California Academy of Sciences, San Francisco, California. President D. D. Jensen presided at the meeting.

The following members were present: A. E. Michelbacher, E. O. Essig, P. H. Arnaud, Jr., G. F. Ferris, L. M. Henry, R. L. Doutt, K. P. Shea, D. H. Groves, S. W. Hitchcock, M. S. Wasbauer, J. A. Powell, E. L. Kessel, F. E. Skinner, B. Barichievich, D. Breedlove, M. Kenny, J. G. Edwards, C. J. Worthington, A. Ross, P. F. Torchio, D. J. Burdick, P. D. Ashlock, D. D.

Linsdale, L. A. Ruud, T. S. Acker, D. M. Maddox, W. E. Ferguson, Jane MacSwain, J. W. MacSwain, E. G. Linsley, W. W. Middlekauff, R. L. Langston, W. A. Russell, D. G. Denning, K. S. Hagen, D. D. Jensen, D. P. Furman, H. B. Leech. Visitors were Martha Michelbacher, Marie Essig, F. D. Bennett, S. M. Sager, Frances Powell, Carl Kaufeldt, Phil Capitate, William Tuft, Beverly Ehreth, Bertha B. Kessel, Terry Seeno, Dolores Damiano, Virginia Ashlock, Barry E. Pullen, Walter E. Rathgen, Nancy MacSwain, John MacSwain, Juanita Linsley, Katherine Furman, Phillis Middlekauff, Evelyn Langston, Elsa P. Russell, Loretta Denning.

The minutes of the meeting held December 7, 1957 were read and approved.

The President announced appointment of the following members to serve as a committee to judge the merits of the entomological exhibits at the annual science fair: Kenneth Hagen, Chairman; Laura Henry, Otto Graph.

Dr. Hagen commented briefly on the nature and mechanics of the award. The first place award consists of an entomological book and a one year honorary membership in the Society. The Society will send letters of commendation to the recipients of the first three places in the judging. The exhibits need not be of the systematic collection type to compete for an award.

The President announced the following changes in membership of standing committees:

Historical—E. O. Essig, Chairman, E. S. Ross, R. L. Usinger, J. W. Tilden, H. B. Leech.

Editorial Board—P. D. Hurd, Jr., Editor; J. A. Powell, H. B. Leech, E. G. Linsley, E. S. Ross, R. L. Usinger, J. E. Swift, R. C. Miller.

Membership—Herbert Ruckes, Jr., Chairman; J. Gordon Edwards, Howard L. McKenzie.

The President discussed briefly types of membership open in the Society with particular emphasis on the student membership category which enables students to enjoy membership at a reduced cost.

Dr. Edwards nominated the following for regular membership: Mr. Johnson C. Montgomery, Dr. Leland R. Brown, Miss Dolores Damiano, Mr. Keith Radford. They were elected by unanimous vote.

The President announced the reinstatement of C. Don MacNeill as a regular member of the Society.

Dr. K. S. Hagen exhibited equipment devised for airplane collections of of *Hippodamia convergens* Guérin. The device is to be used in checking the hypothesis that migration flights of the beetles from their concentration sites in transition zone areas are made in the upper air where easterly winds blow them westward. Previously it was believed that dispersion flights followed down canyons and into the valley. Earlier attempts to follow flights of marked beetles have been unsuccessful. The present airplane trap, which looks superficially like a wing tip fuel tank, has ten discs which may be dropped individually to an exposed position at will. A screen on the disc is supplied with an adhesive substance containing rosin and castor oil; any beetles contacting the disc are expected to adhere to it.

Mr. H. B. Leech discussed the current status of historical files of the Society. Authorization has been granted to obtain another filing cabinet to relieve the congestion in the single file now available for such material. It will be maintained in the Entomological Museum of the California Academy of Sciences, Mr. Leech read excerpts from letters and field notes of early entomologists demonstrating the value of many of the documents on file. Drawings, published and unpublished, are included in the material. Photographs of entomologists and other "curiosities" were placed on exhibit.

Dr. Usinger commented on the data available in the historical files of the academy. He suggested that information on the existence of this material be published in some detail in order to increase its usefulness to interested persons.

Dr. R. L. Usinger reported on interesting habits of reduviid bugs known as resin bugs in Thailand. Kodachrome slides were shown to illustrate *Dipterocarpus* tree-holes with bugs waiting in position near the edge of the resin pools.

Jerry A. Powell showed a vial containing the remains of a caterpillar of a gelechiid moth, *Pseudochelaria manzanitae* Keifer, and some nematodes of the family Mermithidae which had destroyed it. Apparently Mermithids have never been recorded from any North American Gelechiidae. The habitat, manzanita bushes on the very dry hillsides west of Alpine Lake, Marin County, seems to present an interesting problem. Presumably the life-cycle of the worm includes a free living stage in the soil and a certain amount of moisture is necessary to facilitate the parasite's mobility in leaving the host and entering the soil. However, the larvae, which were collected June 6, 1957, normally pupate and transform by late June or early July. Therefore at a locality where one would not expect any June rain, the nematodes apparently must depend upon dew or some other unexplained source of moisture for their return to the coarse, well-drained soil. Six larvae were found infested among 40 collected at random from terminals three to four feet above the ground.

H. B. Leech reported as follows:

"On February 10, 1957, several greenish bees were noticed flying around just outside my kitchen window, in Mill Valley, California. They settled on a galvanized iron pipe to sun themselves, and stayed so persistently within reach that finally one was collected. It was not the common *Osmia lignaria* Say, but another species of the typical subgenus. In Sandhouse's revision of 1939 it keyed to *O. ribifloris* Cockerell, of which the California Academy of Sciences has only a few from California (Mokelumne Hill, Calaveras County, 'Feb.', 'Mar.', F. E. Blaisdell collector; and Altadena, Los Angeles County, also in February, C. D. Michener collector), and none from the San Francisco Bay region. Sandhouse gives merely New Mexico, Arizona, California, Oregon, and does not comment on the date of emergence.

"On February 12, 1958, my son Bill collected another male, within six feet of where mine was taken the year before. Examination shows the species to be nesting in the cracks between cedar shingles, on the south wall of the house." . . .

Mr. Leech also exhibited illustrations of the national butterfly of Japan,

Sasakia charonda Hewitson, together with Japanese stamps picturing the butterfly.

Dr. Kessel introduced a guest, Mrs. Beverly Ehreth, who is a naturalist and teacher at Novato, California, as well as director of the entomological society of the 4-H Club in her area. Dr. Kessel commented on Mrs. Ehreth's recent collection of two Jerusalem crickets which seemed abnormally sluggish. They proved to be infected with horsehair worms, class Gordiacia. Five specimens were released from one insect when it was dropped in water.

Dr. R. C. Miller presented an address on the subject of the Ninth Pacific Science Congress held at Bangkok, Thailand, from November 18 to December 9, 1957.

The first Pacific Science Congress was held in 1920 at Honolulu, where it was organized by the director of the Bishop Museum, H. E. Gregory. Since that time the congresses have been held about every four years. Eight hundred and fifty persons attended the ninth Congress, many more than anticipated. Numerous sections were held to cover fields and problems of interest to the people in and around the Pacific area. Dr. Miller noted a resolution passed at the Congress which urged establishment of a National Muesum of Science in Thailand. Action is expected within a couple years. Numerous interesting color slides were shown of scenes and events covered while attending the Congress.

The meeting was adjourned to the "Coffee Social" at 9:10 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Fifty-eighth Meeting

The two hundred and fifty-eighth meeting of the Pacific Coast Entomological Society was held March 15, 1958, in the Morrison Auditorium, California Academy of Sciences, San Francisco, California. President D. D. Jensen called the meeting to order at 2:05 p.m.

The following members were present: H. B. Leech, G. F. Ferris, L. M. Henry, P. H. Arnaud, Jr., S. W. Hitchcock, D. D. Linsdale, J. A. Powell, J. A. Chemsak, D. Breedlove, H. Ruckes, Jr., D. Burdick W. W. Middlekauff, D. MacNeill, R. L. Langston, W. A. Doolin, J. G. Edwards, L. A. Ruud, Jr., W. E. Ferguson, D. M. Maddox, K. Innes, F. E. Skinner, E. L. Kessel, D. D. Jensen, D. P. Furman. Visitors were: Bruce Hudson, Ben Feingold, Thomas Leech, Barry E. Pullen, Phyllis Middlekauff, Grace MacNeill, Nora MacNeill, Daren MacNeill, Margaret M. Hanna, Karen Engelhart, Nancy Doolin, Peter Westigard, S. Smith.

The minutes of the meeting held February 14, 1958 were read and approved.

Dr. Ruckes nominated Dr. Dennis Hynes of California State Polytechnic College and Dr. Leslie Smith, of the University of California at Davis, for regular membership. He nominated S. M. Sager of the University of California for student membership. The candidates were elected unanimously to the membership categories for which nominated.

The President announced that of the two remaining meetings scheduled for the spring months one is to be held at San Jose State College and the other is to be a field day. He announced the following committee to decide

on a date and arrange for a place for the annual field day meeting: Hugh Leech, Chairman; Herbert Ruckes Jr. and Laura Henry.

Program Chairman Frank Skinner announced April 26 as the probable date for the meeting at San Jose State College. Dr. Tilden and Dr. Edwards have arranged the program for the day.

Dr. Ed Kessel described highlights of his last summer's trip to Alaska, illustrated by a series of beautiful color slides.

Bruce Hudson presented a lecture on the mass culture of fleas for production of flea-bite antigen. He is working on the project as an entomologist with Kaiser Foundation Hospital, under a grant from the U. S. Public Health Service. Dr. Ben Feingold, director of the project was also present.

Dr. Hudson mentioned the early history of flea nuisance in the San Francisco area, known as the "Puebla dc las Pulgas" of the Portola Expedition. He presented color slides of immediate and delayed types of reactions in man following flea bites.

The cat flea, *Ctenocephalides felis* (Bouché), appears to be the most common flea annoying man in the bay area, but the human flea, *Pulex irritans* Linnaeus causes the most trouble by its bite.

Methods were described by which 250–500 thousand cat fleas are reared per week at the laboratory.

An interesting by-product of the investigation has been the finding that what at first appeared to be morphologically identical strains of *Pulex irritans* contain at least two, and perhaps three distinct species. These differ physiologically, among other ways, in adaptation to different hosts. The San Francisco form is the typical *Pulex irritans*, well adapted to man. It is the only one of the complex studied which has been maintained successfully on human blood.

Following a brief discussion the meeting was adjourned to the "Coffee Social" at 3:50 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Fifty-ninth Meeting

The two hundred and fifty-ninth meeting of the Pacific Coast Entomological Society was held April 26, 1958, in the Science Building, San Jose State College, San Jose, California. President D. D. Jensen called the meeting to order at 2:00 p.m.

The following members were present: D. D. Jensen, W. E. Ferguson, R. F. Schoeppner, W. H. Lange, F. R. Cole, J. W. Tilden, P. H. Arnaud, Jr., H. B. Leech, K. S. Hagen, P. S. Bartholomew, R. P. Allen, E. G. Linsley, H. Ruckes, Jr., D. J. Burdick, D. D. Linsdale, K. Radford, R. C. Whitney, R. L. Doutt, K. P. Shea, F. E. Skinner C. J. Worthington, W. W. Middlekauff, J. G. Edwards, D. Damiano, D. Breedlove, T. H. Lauret, D. P. Furman. Visitors were: J. P. Figg-Hoblyn, Pauline L. McMasters, Stephanie S. Ferguson, Douglas W. Price, James M. Code, Fred J. Santana, Vernon W. Nellis, Carl H. Lindroth, John Harville, David Bartholomew, May S. Drei, Joan Gerdts, Perry Allen, Peter Westigard, Carol Radford, A. Sanchez, Myrnadel Guzman, Wesley L. Bond, M. Susan Gardner, Lorance W. Harwood, June Haslett, Julia Hoagland, Robert E. Dolphin, S. Smith, Fred Bennett, L. E. Caltogirone, Robert Kolling, Robert Fox, Roger Lasch, Ronald

S. Daniel, Albert E. Crane, R. N. Ito, David Huntzinger, Terry Seeno, Leta Rae Lauret, Homer H. Eastman, Robert V. Gauthier.

Dr. Ellis, Acting Chairman of the Department of Biological Sciences of San Jose State College, read a welcoming message from Dr. C. D. Duncan, who was absent due to illness.

The minutes of the meeting held March 15, 1958 were read and approved following correction.

Dr. J. G. Edwards nominated Mr. Terry Seeno of San Jose State College for a membership in the Society. Mr. Seeno was elected to regular membership by unanimous vote.

The President announced as winner of the best entomological collection of the Fifth Annual Bay Area Science Fair, Charles Cushner of Lincoln High School, San Francisco. His project: Coleopteran survey. His teacher: W. F. Monahan. Two other collections chosen for honorable mention were those of:

1. David Cavagnaro of Tamalpais High School, Mill Valley. His project: Preserving insect larvae. His teacher: Katherine M. Flanagan.
2. Bradford S. Perry of Vallejo Senior High School, Vallejo. His project: Lepidoptera of California. His teacher: C. G. Aldrich.

Dr. Kenneth Hagen and his committee were commended by the President for their efforts in judging the entomological exhibits at the Science Fair.

Hugh Leech announced that the annual field trip of the Society would be held May 24 at Russelman Park, Contra Costa County.

In response to the President's call for notes and exhibits Vernon W. Nellis exhibited specimens of Cerambycidae, *Necydalis barbarae* Rivers and *Necydalis cavipennis* LeConte, both species of which were collected at his home in San Carlos, California. The collection area is near the hills with nearby chaparral, eucalyptus, bay, and oak trees as well as many other plants. Four specimens of the uncommon species, *N. barbarae,* were found in mid-August of different years. The feeding place is unknown. The specimens are almost 1½ times as large as the ones described in Dr. Linsley's key to the tribe Necydalini.

David Huntzinger, of San Jose State College, exhibited a wingless tipulid collected from a snow bank at Crater Lake Park, Oregon.

Dr. J. G. Edwards discussed the collection of insects above timberline, illustrating his account with a series of beautiful color slides.

Mrs. Pauline McMasters described her work and conclusions on the question of segmentation in the head of the polychaete annelid, *Nereis.*

Dr. John Harville discussed work of the San Jose State College Field Station, with particular reference to studies on food habits of trout in California mountain lakes. An interesting series of color slides enhanced the presentation.

Dr. J. W. Tilden talked about the alpine butterfly associations at Tioga Pass, Yosemite National Park. He stressed three main points as follows:

Firstly, there are several plant associations in the vicinity of Tioga Pass and each has its own characteristic butterflies. Some associations have only one characteristic species, others have several. One aspect of the study he

hopes to make, is to map more completely the components, both plant and butterfly, of each association. As an example, the morraines near the pass are covered with white-bark pines and with several herbaceous plants characteristic of these areas. *Icaricia shasta* Edw., *Thorybes nevada* Scud., *Euphydryas nubigena* Behr and *Lycaena cupreus* Edw. are butterflies typically found there. Of course they also may be found higher in similar areas. But let one walk a few feet down into the meadows, and one finds *Plebeius saepiolus* Bdv., *Colias behrii* Edw., and other species not found in numbers on the morraines. Dr. Tilden interprets this to be due to the drainage and soil conditions, favoring the food plants of the respective butterflies.

Secondly, there is a definite succession of species during the summer. Drier areas warm up sooner. The meadows even when not excessively elevated are colder, and butterflies appear there later than they do on the drier areas. This is evident even when the dry areas are much more elevated. So we get the interesting phenomenon of elevational reversal. Butterflies are flying around the peaks before they appear in the meadows below. Each species seems to have a definite season of flight earlier or later, just as at lower elevation. This is in contrast to the usual concept of the uninitiated, who might suppose that everything comes out at the same time at higher elevations. Data as to how this succession takes place is one aim of the study.

Thirdly, the time of emergence of a given species is evidently different in different years, depending on the time the season opens up. This scems to be due to amount of snowfall, as well as temperatures leading to melting of the snow. The extent to which emergence varies in different years could be correlated with known weather for the year if sufficient data were obtained.

He added that weather data if given as daily temperature and wind velocity, might be used to show that free flight of these alpine butterflies depends on two factors: direct sunlight and wind velocity. Observation will tell you that these butterflies will cease flight when a cloud passes over the sun. Likewise they cease flight at high wind velocities. Because of the low ground temperatures, they seem more sensitive to these factors than, for instance, butterflies under desert conditions, where ground temperatures are high.

In commenting upon Dr. Tilden's talk, Dr. E. G. Linsley stated that he and Dr. J. W. MacSwain had observed the emergence of *Vanessa cardui* L. over several hundred square miles of the Mojave Desert which appeared to be the major source of the butterflies in the widespread flights in the Central Valley during the second week of April. Apparently the extensive fields of annual plants which appeared in response to suitable late autumn rainfall provided unusually favorable conditions for the build up of *Vanessa* populations. He stated that Boraginaceae were particularly subject to attack by larvae and that in many sections of the desert nearly all of the *Cryptantha* was defoliated. *Amsinckia*, *Lupinus*, and *Sphaeralcea* were also heavily attacked in local areas following defoliation of *Cryptantha*. In some places it was difficult to walk without crushing pupae. Residual populations had produced a large larval population, most of which would probably not mature because of lack of food. On the Colorado desert, evidence was found of a large but earlier emergence, perhaps a generation ahead of that on the

Mojave. During the April flights the migrating butterflies provided a definite hazard in the San Joaquin Valley because they obscured windshields. Blackbirds and English Sparrows feasted on the dead butterflies on the shoulders of the highway. The general trend of the flights was northerly or northwesterly, although the pattern varied from time to time.

Dr. Hagen and Dr. Middlekauff commented on the recent abundance of *Vanessa* in the Kettleman Hills and Marysville areas of California.

Dr. John P. Figg-Hoblyn presented an address on the interpretation of the "dual innervation" of the apterygote antenna with reference to cephalic segmentation.

Due to the absence of Dr. Duncan his address entitled "Entomology at San Jose State College," was read by Dr. Tilden. The growth of the entomology program at the college from 1930, when general entomology first was placed on its curriculum, to its current, varied offerings and facilities is indicative not only of the increasing significance of the field but also of the enthusiasm of a dedicated staff. The meeting was adjourned at 4:10 p.m. —DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixtieth Meeting

The annual field meeting of the Pacific Coast Entomological Society was held at Russelman Park, Contra Costa County, May 24, 1958. The following members were present: Jane MacSwain, W. W. Middlekauff, Robert L. Langston, Jon L. Herring, John A. Chemsak, Deane Furman, Ed Swift, Hugh B. Leech, D. D. Jensen, E. G. Linsley, J. W. MacSwain, Herbert Ruckes, Jr., J. W. Tilden, Wm. A. Russell, Paul H. Arnaud, Frank E. Skinner, D. G. Denning, A. Earl Pritchard, Bill Ferguson, Donald M. Maddox, Charles Cushner. Visitors were Juanita Linsley, Kay, Lynne, Bryan and Phil Furman, Phyllis and Dave Middlekauff, William and June Simonds, Dick Gardiner, Evelyn and Ann Langston, Mrs. Jon L. Herring, Mrs. Jerry Powell, Mary Ann MacHenry, Riley and Tim Swift, Patricia and Carol Jensen, Nancy, Lyn and Ginger Ruckes, Hazel, Jimmy, Bernice and Jan Tilden, Marguerite Arnaud, David Skinner, Loretta Denning, Marie Moor, Stephanie, Rickie and Robin Ferguson, Ann and Debbie Maddox, Mary, Thomas and Bill Leech.

The pleasant, sunny afternoon was spent in picnicking, visiting with old and new friends, collecting, and enjoying the recreational facilities of the park.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-first Meeting

The two hundred and sixty-first meeting of the Pacific Coast Entomological Society was held October 17, 1958, in the Morrison auditorium at the California Academy of Sciences, San Francisco, California. President D. D. Jensen called the meeting to order at 7:40 p.m.

The following members were present: E. S. Ross, O. Bryant, G. A. Samuelson, J. Gordon Edwards, Terry Seeno, W. A. Doolin, E. O. Essig, A. E. Michelbacher, Paul A. Harvey, Richard Dahl, Kenneth S. Hagen, Y. Tanada, Don Burdick, Ibrahim K. Kaddou, Paul H. Arnaud, Jr., Frank E. Skinner, Evert E. Lindquist, Jerry A. Powell, Otto W. Graff Jr., Laura M. Henry, T. S. Acker, William Russell, K. P. Shea, R. L. Doutt, J. W. MacSwain, Jane MacSwain, Herbert Ruckes, Jr., Paul D. Hurd, Jr., William E.

Ferguson, D. D. Jensen, Dick Wilkey, Edwin Cott, Dennis Hynes, W. W. Sampson, John A. Chemsak, Dennis Breedlove, W. D. Murray, Don MacNeill, J. W. Tilden, J. H. Freitag, Richard Bushing, C. J. De Mars, D. P. Furman. Visitors registering were: Edgar A. Smith, L. Caltagirone, Sterling Bunnell, M. W. Bunnell, M. Ayron, G. Pronin, David H. Huntzinger, Patricia, Carol and Anita Jensen, Nancy Doolin, Marie W. Essig, Martha Michelbacher, Kay M. Furman, Tom Leech, Ed. W. Kirschbaum, D. C. Rentz, S. D. Smith, K. W. Brown, Mr. and Mrs. R. C. Elliott, Mr. and Mrs. Peter Rubtzoff, Dorothy and Lynda Dahl, R. H. Van Zwalenburg, Mr. and Mrs. G. L. McGill, Philip S. Barker, Theo F. Watson, Barry E. Pullen, F. X. Brace, L. Brace, Margaret Cooper, Maxine Lindquist, Frances C. Powell, Anne Graf, G. J. Haughey, M. Haughey, Elsa P. Russell, Ricky and Jeff Doutt, Ralph J. Black, Art Smith, Lois B. McNally, James H. McNally, Keith A. Scott, Jen Scott, Jeanette and Calvin Rogers, Catherine Tosski, Mrs. W. D. Murray, Nancy MacSwain, Mrs. C. G. Noack, John MacSwain, Elias Tuma, Paul Kraemer, George P. Willsey, Gerard M. Thomas, David L. Wood, Glenn Kissinger, Doris Fujimoto, Judy Yamada, Ron Hall, John E. Henry, Melora Hilbert, Leon Spreyer, P. Watson, Dick Halbert, Richard H. Whitsel, Fred J. Santana, Dorothy De Mars, Kathleen Conrey, David Bettencourt, Onkar Singh Bindra, K. R. Thakare, R. Toschi, Nancy Ruckes, Grace Hurd, Kathryn Hurd, W. W. Allen, Frank B. Hicks, Stephanie Ferguson, Mrs. R. F. Wilkey, José Rutilio Inezada, Woody Hilbert, D. Giuliani.

The minutes of the meetings held April 26 and May 24, 1958 were read and approved.

The President announced appointment of a Nominating Committee to select a slate of nominees for officers for 1959. The committee consisted of Dr. Kenneth Hagen, Chairman; Dr. E. S. Ross and Dr. J. W. Tilden. He also announced the appointment of an Auditing Committee composed of Dr. E. L. Kessel, Chairman; Dr. J. W. MacSwain and Dr. J. Gordon Edwards.

The President reported the death of one of the Society's most valued members, Professor G. F. Ferris. A special issue of the Pan-Pacific Entomologist is to be devoted to the memory of Professor Ferris.

Laura Henry announced that contributions are still being accepted for the Gordon F. Ferris Memorial Fund, which will be used to provide a scholarship in entomology.

Mr. H. B. Leech stated that Mrs. Ferris has donated drawings and other items of interest to the Society's historical file. The Society owes thanks to Mrs. Ferris for her generosity.

Dr. Ed. Smith, who recently returned from Indonesia, announced that twenty to thirty foreign service positions are available for medical entomologists. Entomologists, either with or without previous field experience, are being considered. The program is sponsored by the International Cooperation Administration.

Dr. Ruckes nominated the following individuals for membership in the Society:

Leopoldo Caltagirone, Entomology student from Chile, currently at the University of California.

F. F. Bibby, Arizona Fertilizer Company, Phoenix, Arizona.

Dr. George D. Butler, Jr., Dept. of Entomology, University of Arizona.
Mr. Van Zwalenburg, retired entomologist of the Hawaiian Sugar Planters' Association, now residing in Santa Rosa, California.

Dr. Edwards nominated for membership:

Mr. David H. Huntzinger, student at San Jose State College.

The nominees were elected unanimously to regular membership.

In response to the President's call for notes and exhibits Dr. Doutt described the life history of a gall wasp which has an alternation of generations. This is the first proven case of heterogony among California cynipids and was worked out simultaneously, independently, and without knowledge of the other's research by Mr. Robert Lyons of Los Angeles City College and Dr. Doutt.

The species is *Dryocosmus dubiosus* (Fullaway). It produces a bisexual generation in early spring which develops in the male aments of the black oaks. The mated females oviposit in the veins of the leaves. The eggs are slow in hatching for the first larvae appeared only after two months and some eggs were found to be viable and to hatch as long as six months after deposition. Dr. Doutt found that unlike other Hymenoptera the unfertilized eggs of this species do not develop parthenogenetically, and he suggests this may be unique.

The galls produced on the leaves are bicornate and from them emerge a uni-sexual generation of females. Dr. Doutt found these to be of two types: one type produces female progeny only, whereas the other produces males exclusively. The wasps from these leaf galls were originally described as a distinct species in a separate genus, and the present biological study shows they must now be synonymized with *D. dubiosus* which has priority. Dr. Doutt objects to the use of trinomials to designate alternate generations, and furthermore believes that the common usage of the terms sexual and agamic generations is erroneous for the agamic generation is really sexual. He would propose that the binomial be used and then followed by an appropriate designation of either bisexual or unisexual generation which is both descriptive and accurate.

Mr. Hugh B. Leech stated that in the minutes of the 232nd Meeting of this Society, he recorded *Stator limbatus* (Horn) as occurring in some numbers at Lucerne, Lake County, California, in August, 1953 (Proc. Pacific Coast Ent. Soc., *in* Pan-Pacific Ent., 30 (1):85–86. 1954). In mid-August, 1959, he and his family were camping on the grounds of Cottage City Resort at Lucerne. Adults of *S. limbatus* were flying in numbers during the heat of the day, and annoying people by settling on them. The beetles were almost as persistent as small flies, and two of those which got on his skin gave an appreciable nip with their mandibles. Seed pods were maturing on adjacent black acacia trees (*Acacia melanoxylon* R. Br.) at the time, and the bruchids were readily obtained by jarring branches. It was difficult to get even fifty per cent of those knocked onto a beating sheet, though, because they took flight almost as they landed.

Dr. J. W. Tilden noted that the summer season was longer this year at high elevations in the Sierra Nevada as compared with the same season of the preceding three years (1955, 1956, 1957). Whereas in 1957 no insects

were flying after September 1, in the same area above Tioga Pass, Yosemite National Park, this year many insects were flying on September 3.

Of particular interest was the presence of several specimens of *Parnassius clodius baldur* Edwards. This insect normally flies earlier in the season and at much lower elevations. On September 3, 1958, it was flying at an elevation of 11,000 feet, in the Alpine Fell-fields Association, an area where *Parnassius smintheus behrii* Edwards is normally found in July and August. This elevation is not the usual habitat of *P. clodius*.

Mr. D. H. Huntzinger exhibited two *Cimex pilosellus* (Horv.) and four *Basilia forcipata* Ferris, taken from *Myotis* species collected in Oregon Caves National Monument, September 8, 1958. He also noted the collection of one *Silpha surinamensis* Fabricius taken at Crater Lake National Park on September 4, 1958, under a deer carcass. This eastern species of Silphidae may be a new record for Oregon.

J. G. Edwards displayed a specimen of the brilliant green buprestid, *Trachykele opulenta* Fall, which was collected by Mrs. Vaughn in Cambria, California. Ecological data are not yet known concerning this specimen, but it is believed that this is a significant extension of the known range of this species.

Edwards also displayed a reduviid of the genus *Triatoma* which had hospitalized a San Jose rancher the previous week with severe nausea, widespread rash, dizziness, and so forth. When he returned home he found the bug resting beneath his pillow. It feigned death for two days but when heated on the stove it jumped into action and was as lively as a spider. When it cooled, it again feigned death, for two more days, until heated again. This procedure has been repeated again, but the specimen now is "looking dead" again.

Dr. Usinger commented on bites of *Triatoma* in California. He stated that in an average year about four such cases of severe reaction to the bites of the bug are reported. The severity of reaction seems associated with increasing sensitivity following successive bites.

Dr. E. S. Ross next presented the main address of the evening, dealing with his recent extensive collecting trip in Africa. His major research interest, study of the insect order Embioptera, requires personal collection and observations in the major tropical regions of the world. Photographic records of the natural history of these areas, particularly that concerned with insects, has become a major by-product of the research. Dr. Ross described highlights of his 26,000 mile trip through Africa. Ample evidence of the endless opportunities for filming little known fauna and flora of the area was presented in the form of a series of wonderful color slides.

The meeting was adjourned to the "Coffee Social" at 10 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-second Meeting

The two hundred and sixty-second meeting of the Pacific Coast Entomological Society was held December 13, 1958, in the Morrison Auditorium at the California Academy of Sciences, San Francisco, California. President D. D. Jensen called the meeting to order at 1:10 p.m.

The following members were present: R. L. Doutt, Herbert Ruckes, Jr.,

D. P. Furman, D. D. Jensen, F. E. Skinner, E. L. Kessel, P. D. Hurd, Jr., R. L. Usinger, E. O. Essig, K. S. Hagen, J. H. Freitag, R. W. Thorpe, D. D. Linsdale, E. E. Lindquist, J. A. Powell, J. W. MacSwain, T. S. Acker, R. L. Langston, J. W. Tilden, W. D. Murray, L. E. Caltagirone, P. H. Arnaud, Jr., C. D. MacNeill, C. Cuschner, P. A. Harvey, D. J. Burdick, W. A. Doolin, A. E. Pritchard, J. A. Chemsak, E. S. Ross, M. Wasbauer, R. C. Miller. Visitors registering were: H. Ruckes, Sr., John MacSwain, James Milstead, Derham Giuliani, Woody Hilbert, H. Bikler, K. W. Brown, Marshall Reed, Nancy Doolin, Jack R. Powers.

The minutes of the meeting held October 17, 1958 were read, amended and approved.

Dr. Ross announced that Mr. Owen Bryant, a long time member of the Pacific Coast Entomological Society, passed away late in October of this year and left the bulk of his estate to the California Academy of Sciences for the benefit of the Department of Entomology. This included the remaining portions of his insect collection and library as well as an endowment fund. Prior to his death Mr. Bryant had already donated a large part of his insect collection to the California Academy of Sciences.

Dr. H. Ruckes, Jr., proposed the following nominees for membership in the Society: Woody Hilbert, Derham Giuliani, Jack R. Powers, Robin Thorpe, C. E. Kennett. They were elected by unanimous vote to full membership.

President Jenson announced that Mr. Van Zwalenburg had been appointed to fill the vacancy in the Publication Committee left by the death of Professor Ferris. Dr. J. Gordon Edwards was appointed as a member of the Special Committee on Nomenclature, and Dr. Usinger was appointed chairman.

The Chairman of the Auditing Committee, Dr. E. L. Kessel, reported the books of the Society were found to be in order.

In response to the President's call for notes and exhibits, Jerry A. Powell exhibited specimens of an unusual tortricid moth, *Synnoma lynosyrana* Walsingham. The species shows remarkable sexual dimorphism which is a very aberrant characteristic among the Tortricidae. The females, having a very large abdomen, seem unable to fly successfully. The genus and the monotypic species were described from specimens collected in 1871 on the plains northeast of Mt. Shasta by Lord Walsingham. The species has subsequently been reared from *Chrysothamnus* from the same area and at least as far north as southern Idaho. The specimens shown were reared from larvae collected on both *Chrysothamnus nauseosus* and *C. viscidiflorus* near Weed, Siskiyou County, California in August, 1958. The larvae live in tough, silken tubes and are often so numerous that they draw up the branches of the host plant into conspicuous bundles. Also shown were the black egg patches of the species which had been laid in late September. Some of the eggs had hatched, but it was suggested that this was probably due to the laboratory conditions, as the larvae died without constructing hibernaculi.

Dr. J. W. Tilden exhibited the larva of a fly of the genus *Microdon*, family Syrphidae, that had been taken by Paul Shafer, a student at San Jose State College. The larva was collected on November 28, 1958, from under the bark of a decayed stump of ponderosa pine, in an area that had

been timbered over about fourteen years ago. The locality was three miles below Georgetown, El Dorado County, California, at an elevation of 2300 ft.

Donald J. Burdick and Marius Wasbauer presented the following paper entitled, Provisioning behavior of *Methocha californica* Westwood.

"The only previous biological note concerning *Methocha californica* Westwood was presented in 1912 at the 46th meeting of this society. At this meeting J. C. Bridwell in a commentary on some rare and little known Hymenoptera, which he had collected, mentioned that the species was 'parasitic in the burrows of tiger beetles.' The first account of *Methocha* as a cicindelid parasite was by Adlerz in 1903 when he observed a female of *M. ichneumonides* Latreille successfully attack and paralyze a large tiger-beetle larva. Since this time a number of observations on this and other species have been reported and in each case a cicindelid larva was used as prey.

"Our observations were made on two females collected by J. Powell and Burdick as they crossed the nesting site of a species of a sphecid which they had under observation. After establishing *Omus californicus* Eschscholtz larvae, admittedly abnormal hosts, in observation burrows, a *Methocha* female would be placed in the jar and watched while she searched, found, paralyzed and oviposited on the *Omus* larva. In all, twelve larvae were paralyzed and eleven eggs were laid by the two *Methocha* females. When first dropped into the jar, the female, moving rapidly and randomly, investigated any depressions or burrows that she came across. Upon finding the occupied burrow, she pointed her antennae down into the burrow and became quiescent. Usually she would then move to the side of the burrow that the host's mouthparts were on and would walk down the burrow toward the host. This orientation placed the female in position to reach the ventral part of the host's neck with her sting. The *Omus* larva, by this time aware of the intruder, had prepared itself to strike. The approach of the *Methocha* was very rapid, and she was able to place at least her first two pairs of legs on top of the flat shield formed by the head and prothorax of the host before the larva lunged upward, raising its head and closing its mandibles upon its attacker. At this time, the female dropped her abdomen down, and the mandibles of the *Omus* closed harmlessly around the wasp's narrow waist. In this position, the female stung her host in the neck, temporarily paralyzing it. She then lifted her abdomen through the now inactive mandibles of her host and climbed out of the burrow. Here she wandered about for a short time and then reentered the burrow and began preparing the host for oviposition.

"After the initial sting delivered by the female *Methocha*, the tiger beetle larva was usually rendered immobile. However, there was some variation in the degree of paralysis. The paralysis was of a very temporary nature, and in most cases eighty to ninety percent mobility was regained by the *Omus* larva within 24 hours.

"Following the initial sting and paralysis of the prey, there was always a secondary stinging response which was altogether different from the first. The female *Methocha* oriented herself so that she faced the venter of the

prey within the burrow, grasped one of the fore or mid coxae in her mandibles, curled her entire body upwards and around and stung the *Omus* larva in the membranous area just behind the head capsule. This was repeated an average of four to five times during the course of a provisioning cycle. We found that we could increase the number of subsequent stings merely by moving the *Omus* larva in the burrow. Apparently movement on the part of the host incited the stinging response.

"After the host larva was stung into quiescence, the wasp engaged in host feeding. She accomplished this by maxillating the venter in the neck region or at the base of one of the coxae. When she succeeded in puncturing the skin she then fed on the exuding blood.

"In preparing the larva for oviposition, the wasp tilted the head capsule of the prey back by pushing it with her head. She then climbed up and grasped the head capsule with her fore and middle legs, moving her abdomen around until it contacted the hind coxa of the host larva. The abdomen was then moved back and forth several times and the egg extruded. The egg was always placed mesally at the base of the hind coxa and its position was relatively constant. This constancy is understandable when we consider that the prey recovered rapidly and was able to move about in the burrow. In this position the egg was relatively safe from being crushed or dislodged.

"After oviposition, the wasp began to fill the burrow, usually first by prying material loose from the upper sides of the burrow with her mandibles and then walking out of the burrow to search for pieces of material of suitable size, which she carried in her mandibles and placed on the cephalothoracic shield of the prey. We noted no raking of material with the front legs, a trait characteristic of so many aculeate wasps.

"The egg hatched in from four to five days and the first instar larva remained in the same position as the egg had been, feeding suctorially on the body juices of the host. This suctorial feeding continued up to the time of death of the host, in about ten to twelve days. By this time, the *Methocha* larva was quite large and moved about freely, often feeding inside the body of the dead *Omus* larva. The active larval period of the parasite was completed in twelve to fifteen days. Two of the larvae formed cocoons. The adults will probably not emerge until next spring."

The talk was illustrated by a series of excellent color slides.

Dr. Hagen, as Chairman of the Nominating Committee, announced that the following members had been nominated for officers for 1959: R. L. Doutt, President; R. M. Bohart, Vice-President; D. P. Furman, Secretary; R. C. Miller, Treasurer. No further nominations were received from the floor. The nominees were unanimously elected to office.

President Jensen turned over the chairmanship of the meeting to incoming President Doutt.

Dr. Jensen delivered the Presidential address entitled "Insects—Both Hosts and Vectors of Plant Viruses." The text of his stimulating address is to appear as a separate paper in the Pan-Pacific Entomologist.

The meeting was adjourned to the "Coffee Social" at 3:40 p.m.—DEANE P. FURMAN, *Secretary*.

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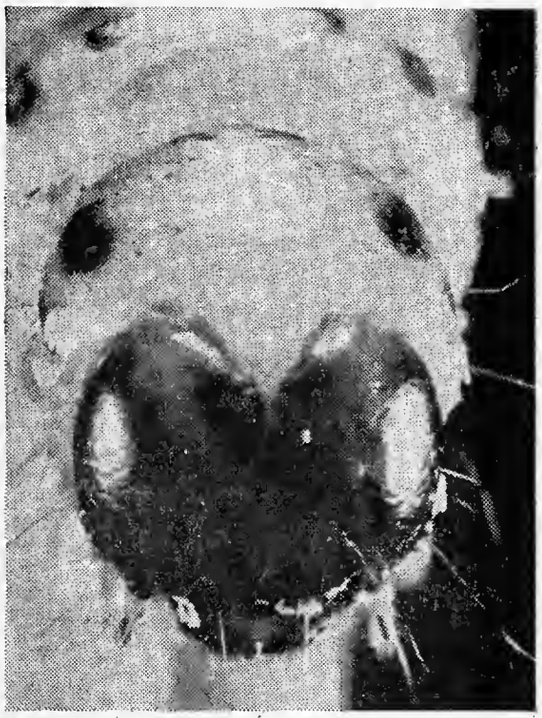

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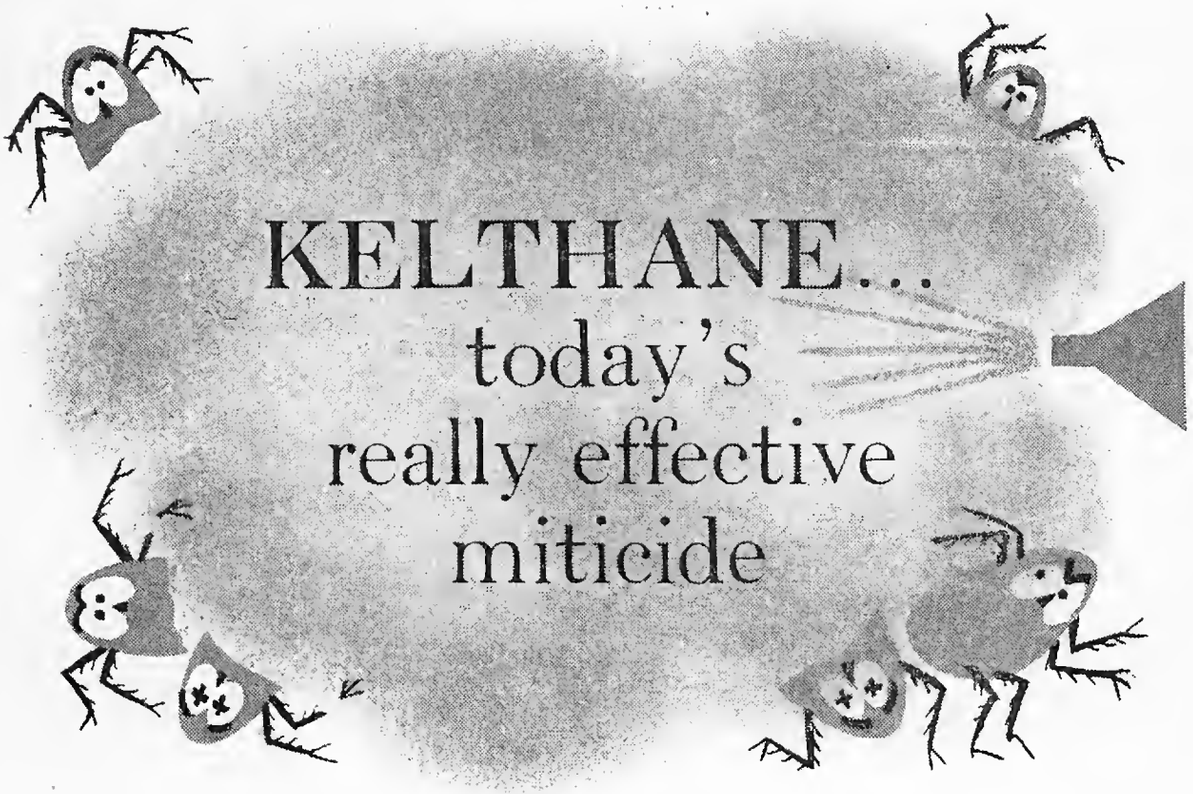

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THE PAN-PACIFIC ENTOMOLOGIST

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THE PAN-PACIFIC ENTOMOLOGIST

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Manuscripts for publication, proof, and all editorial matters should be addressed to J. A. Powell, at 112 Agricultural Hall, University of California, Berkeley 4, Calif. All communications regarding non-receipt of numbers, changes of address, requests for sample copies, and all financial communications should be addressed to the treasurer, Dr. R. C. Miller, at the California Academy of Sciences, San Francisco 18, California.

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INSECTS, BOTH HOSTS AND VECTORS OF PLANT VIRUSES[1]

D. D. Jensen

University of California, Berkeley

Man, in his attempts to explain the observed phenomena of nature, travels from naive conjectures to the complexities of experimental facts and then seeks generalized simplicity. In the field of virus research we are still in the complex stage in which every generalization proposed has at least one Achilles Heel. A Newton of viruses has not yet appeared on the horizon. Nevertheless, the chase is on and in scores of laboratories throughout the world the quarry is being glimpsed at closer and closer, though still distant, range. Most avidly pursued of all is tobacco mosaic virus which must scarcely dare call its nucleic acid its own.

Among the most complex and least understood of the plant viruses are those which rely heavily or exclusively on insects for their dissemination in nature. The relationships of viruses to their vectors have been studied by a relatively small group of research workers. Yet evidence is accumulating that the insect vector, far from being merely a "flying needle" contaminated with virus, as some have been inclined to consider it, may prove to be the pristine host of some, if not all, plant viruses.

I should like to review some of the more interesting discoveries and hypotheses involving vector-virus relationships, particularly the recent ones and those dealing primarily with the leafhopper transmitted viruses.

Some important discoveries have been made accidentally or as by-products of planned investigations; others have required the penetrating thought and imagination so perceptively described by Schopenhauer (and recently quoted by a colleague) when he said: "Thus the task is, not so much to see what no man has seen yet, but to think what nobody has thought yet, about that which everybody sees."

Why is a Vector a Vector?

The vast majority of known plant virus vectors are insects. Eriophyid mites are also proving to be important vectors of a

[1] Presidential address, presented to the Pacific Coast Entomological Society, December 13, 1958.

few viruses in recent years. This year for the first time, a non-arthropod was demonstrated to transmit a plant virus when Hewitt *et al.* (1958) reported *Xiphinema index* Thorne and Allen, a plant parasitic nematode, to be a vector of grape fan leaf virus.

One of the basic questions in vector-virus relationships, and one about which we are still almost completely ignorant, concerns the factors which govern the transmissibility of viruses by vectors. The vectors of most plant viruses show general but not inflexible phylogenetic affinities. Thus, aphid-transmitted viruses have not been shown conclusively to be transmitted also by leafhoppers, beetles or other insect groups. Viruses associated with leafhoppers are transmissible only by leafhoppers—except in the case of Pierce's disease virus of grapes which is carried by spittle bugs of the family Cercopidae and by sharpshooters in the family Cicadellidae, but not by other leafhoppers. The common denominator among all the vectors of this virus is their habit of feeding in the xylem rather than the phloem of the plants.

There appears to be less group specificity among the vectors of animal viruses. For example, the experimental vectors of the virus causing western equine encephalitis include ticks as well as mosquitoes.

Bennett and Wallace (1938) have shown that the curly top virus of sugar beets, transmitted in the United States only by *Circulifer tenellus* (Baker), can be acquired and carried in the bodies of aphids, mites, thrips and other leafhoppers for long periods of time, but is not transmitted by these species.

The specific cause for failure of a virus to be transmitted by non-vector species or by a genetic strain of its normal vector has been demonstrated only once. Storey (1939) bred a strain of *Cicadulina mbila* (Naudé) which consistently failed to transmit maize streak virus in Africa. However, these "inactive" individuals could be made active vectors if, after they had fed on a diseased plant, the stomach wall of the insects was punctured with a fine needle to permit some of the infective plant juice to enter the blood in the body cavity. This showed that the barrier to virus passage existed in the wall of the intestine.

Present evidence suggests that the constitutional stability of insects as vectors of plant viruses is much greater than are the viruses which they transmit. However, this does not imply that

vector species are homozygous in this respect and show uniformity and consistency in transmitting ability.

Björling and Ossiannilsson (1958) have just published the results of extensive experiments involving 10 asexually reared strains of six different species of aphids as vectors of two persistent viruses, beet yellows and potato leaf roll. The aphids were: *Myzus persicae* (Sulzer), *M. ascalonicus* Doncaster, *Aphis fabae* Scopoli, *Aulacorthum circumflexum* (Buckton), *A. solani* Kaltenbach) and *Macrosiphum euphorbiae* (Thomas). Nearly all of the strains of *Myzus persicae* were better vectors of both potato leaf roll and beet yellows virus than were the best strains of the other aphid species compared.

Most of the work dealt with 85 strains of *Myzus persicae* which had been collected from widely different geographical and ecological sources. Virus transmission tests over a three year period revealed that these 85 strains could be grouped in a continuous series which ranged from 10 per cent to 80 per cent in virus transmitting ability. Moreover, there was no correlation between the field source plant of the aphid strain, nor the plants on which the aphids fed just prior to being used in virus tests, and their efficiency as vectors.

Most of the strains were fairly efficient vectors with individual aphids of 70 of the 85 strains transmitting beet yellows virus to 30 per cent or higher of the test plants. The absolute differences in transmission efficiency were great between some strains and significant in a number of cases. The authors were led to conclude that "these differences between more or less effective vector strains within the same species seem to be genetically determined." This was also supported by tests in which two aphid strains of similar vector efficiency were crossed. The efficiency of the progeny was markedly below that of the parents.

Loss and Recovery of Insect Transmissibility by Viruses

There is now considerable evidence that the insect transmissibility of many plant viruses is not constant, but varies sometimes in relatively short periods of time. For many years it has been the not uncommon experience of those who work with insects and viruses to find that known vectors of certain viruses sometimes transmit them inefficiently or not at all. Very often this is encountered after an interruption of transmission work for several months or years. It is apparently often due to a reduction in virus

titre in a plant which has been infected for an extended period of time. However, in other instances it may occur with viruses whose titre has been maintained at a high level by frequent transmission to new plants or animals by means of mechanical inoculation.

Transmissibility by mosquitoes of certain strains of yellow fever, encephalitides and dengue viruses is greatly reduced or eliminated after repeated passage by mechanical means in the vertebrate hosts (Reeves, 1958).

Viruses are known to mutate and it is probable that vectorless mutants may appear which, in the absence of insect transmission, might supplant the insect transmissible virus strain.

Black (1953) maintained three isolates of potato yellow dwarf virus for 12-16½ years in plants without insect transmission. At the end of this period the leafhopper vector was unable to transmit these isolates whereas control leafhoppers transmitted fresh isolates of the virus, collected in the field, with normal high frequency. Very recently Black *et al* (1958) reported the same phenomenon for wound-tumor virus and its leafhopper vector.

Similar loss of transmissibility by aphids was reported by Hollings (1955) for tomato aspermy virus. One isolate, at first easily transmitted by aphids, was transmitted only with great difficulty by vectors after two years of mechanical transmission to tobacco.

I worked with an aphid transmissible virus of garden nasturtium, *Tropaeolum majus,* over a period of several years. Vector work was then discontinued for approximately two years during which the virus was transmitted by juice inoculation every few months. When aphids were tried again as vectors transmission occurred only rarely. Field collected *Myzus persicae* were also tried as vectors but they succeeded no better than did our greenhouse colonies.

In the above cases loss of transmissibility by insects followed two or more years of virus maintenance or transmission in the absence of insects. Swenson (1957) reported that one of two isolates of bean yellow mosaic virus lost its ability to be transmitted by three species of aphids within a period of one to four months.

The most obvious explanation suggested by these results is that the virus isolates in question lost their ability to be trans-

mitted by their normal vectors as a result of mutations of the virus. Since the tomato aspermy virus isolate became almost completely vectorless in a two-year period it may be inferred that the alleged mutant strain was replacing the insect transmitted strain gradually. In contrast to this, however, is the fact that Swenson's bean virus apparently became completely vectorless within one to four months after having been transmitted readily by three species of aphids.

That the apparent loss of insect transmissibility by a virus may be reversible has been reported by Watson (1956, 1958). Potato virus C, derived from potatoes, was not transmissible by aphids. However, after mechanical inoculation into *Nicotiana glutinosa* this virus could be transmitted by *Myzus persicae*. When returned to potato by means of aphids, the virus ultimately reverted to the vectorless strain although certain isolates remained aphid transmissible through several passages in potato.

The first speculative explanations suggested by this phenomenon were of two different types. One involved possible mutations; the other required a quantitative rather than a qualitative hypothesis and postulated vectorial and vectorless virus particles which varied in ratio in the different hosts. Each of these hypotheses required assumptions that are without precedent.

What may prove to be a more plausible explanation has just been reported. Badami and Kassanis (1958) obtained a strain of potato virus Y, from *Solanum jasminoides* from India, which in potato closely resembled the potato virus C used by Watson. However, after separation from two other viruses which were also present in *S. jasminoides*, this virus was readily transmitted by *Myzus persicae*. These previously undescribed viruses are reported to decrease the multiplication of the virus Y strain and also its aphid transmissibility.

This suggests that Watson's potato virus C may not be aphid-transmissable from potato because of the possible presence in potato of another virus which reduces or prevents transmission of virus by aphids. Tobacco may not be a host of this virus and thus virus C would be available for transmission by aphids.

This phenomenon is just the opposite of that reported by Smith (1945) for the virus complex known as tobacco rosette. One component, mottle virus, is easily transmitted mechanically but

cannot be transmitted by *Myzus persicae* unless it occurs in the same plant which carries vein-distorting virus.

Cross Protection Between Viruses in Insects

Although plants are not known to produce antibodies to infective disease agents such as we know to be common in animals, plants, after infection by a virus, may acquire immunity to related and sometimes more virulent strains of the same virus. The different strains have been assumed to arise through mutation, but there is now evidence that genetic recombination may also be involved. The ability of one virus strain to prevent a second strain from producing its own characteristic disease symptoms in the same plant has been considered evidence that the two strains are closely related. However, it is also possible to have closely related strains, such as those of curly top virus of sugar beets, which do not protect against each other either in the plant or in the insect vector (Giddings, 1950).

Kunkel (1955) showed that the California and the eastern U.S. strains of aster yellows virus protect against each other in some of their common host plants. He also obtained evidence that the same strains protect against each other in the aster leafhopper, *Macrosteles fascifrons* (Stål). Working with groups of leafhoppers, he found that those which fed for two weeks on plants infected with one strain of virus and then fed two weeks on plants carrying the other virus strain, always transmitted only the first strain.

Experiments of several different types have demonstrated that aster yellows virus multiplies in the aster leafhopper as well as in the plant. Although the mechanism of cross protection among viruses is not known, it has been inferred that related strains need the same materials for multiplication and that the first virus to invade a host occupies the sites of virus multiplication and uses up the materials available, thus denying to the challenging strain the products it needs for multiplication.

However, more extensive experiments by Freitag (1958) in California with three strains of aster yellows virus and the aster leafhopper have shown that cross protection is not always stable and permanent. Working with single insects and transferring them daily over long periods of time, he found that under some circumstances the leafhoppers finally stopped transmitting the first strain acquired and then transmitted the challenging strain. These were,

however, exceptional cases. In most instances there was marked cross protection in both insect and plant.

Maramorosch (1957, 1958a) has reported the same phenomenon with two strains of corn stunt virus and its vector *Dalbulus maidis* (DeLong & Wolcott). In the studies conducted with aster yellows virus and with corn stunt virus, one strain in each disease complex showed greater dominance than the other in both the insect vector and the host plant. In the leafhoppers, strain "A", acquired first, was sometimes replaced by strain "B". However, if strain "B" was acquired first, strain "A" failed to supplant it. This indicates that the phenomenon of cross protection is more complex than mere prior occupancy of virus multiplication centers in the insect or plant by the first strain to enter.

Our perplexity regarding the nature of this apparent competition between plant virus strains within the body of the leafhopper vector is compounded by the nature of strain replacement in the insect. In a few instances, test plants fed on by single insects showed symptoms of both virus strains. In most cases, however, symptoms were entirely of one strain or the other. Also, replacement of one strain by a more dominant strain within the same leafhopper was not always permanent when first accomplished. Sometimes the strains were transmitted alternately before the dominant strain finally completely supplanted the other.

The presence and multiplication of two virus strains in the same leafhopper vector have not yet been known to result in a new hybrid virus. However, more extensive tests involving related virus strains carried by the same vectors might produce new hybrid plant viruses in insects as it has in plants and in vertebrate animals.

Recombinations of genetic units between related strains of animal and plant viruses have already been reported. The first work of this type was done by Burnet and Lind (1951) with strains of influenza virus. Subsequently, Best and Gallus (1955) and Best (1956) achieved similar results with tomato spotted wilt virus. Plants infected with mixtures of two strains of this virus developed symptoms of both parent strains and also symptoms of new strains. From these plants with mixed infections they recovered both parent strains and also several new strains. The latter were distinct from each of the parent strains but possessed some of the characters of each parent. Further experiments led

to the conclusion that such new strains were genetically stable and not mere mixtures of the two parent strains.

It would be of great interest to determine if parallel results could be obtained by allowing the thrips vector to acquire two or more of these same strains of spotted wilt virus. Multiplication of spotted wilt virus in thrips has not yet been demonstrated, but the 5–10 day incubation period of the virus in the vector, plus long retention of the virus by the vector, suggest multiplication.

Beneficial Effects of Plant Virus in Relation to Insect Vectors

A few reports exist indicating that a plant virus may be of indirect benefit to its own insect vector or to a non-vector species. Carter (1939) found that infected *Emilia sonchifolia*, a weed host of both spotted wilt virus and its vector *Thrips tabaci* Lindeman, maintained a higher population of thrips than did healthy plants. The reasons for this appeared to be that diseased plants had curled leaves which provided improved shelter for the thrips vector and that these plants also grew more slowly and survived longer.

A more direct beneficial effect of virus on *Aphis fabae* has been reported by Kennedy (1951). He found that sugar beet mosaic virus altered the physiology of the beet plant in such a manner that the production of young aphids per mother averaged higher on virus infected leaves of all ages than on healthy leaves of comparable age.

Severin (1946), incidental to his search for new leafhopper vectors of aster yellows virus, found that 9 species of leafhoppers completed their nymphal development on celery or asters infected with California aster yellows virus, but that the adults died within a few days after transfer to healthy celery or asters. No data were presented on the longevity of any control adults that may have been held on diseased plants. The results given were interpreted as demonstrating that aster yellows virus in some way altered celery and aster plants so as to make them more suitable food hosts for the leafhopper species tested.

Maramorosch (1958b) reported similar conclusions drawn from experiments with *Dalbulus maidis* (DeLong & Wolcott), a non-vector of aster yellows virus. This leafhopper, which transmits corn stunt virus, was known to feed well and breed only on *Zea mays* and *Euchlaena mexicana*. Eighty adult insects were caged on healthy China asters and 80 were caged on asters infected with

aster yellows virus. All insects on healthy asters were dead within four days, but 63 of 80 were still alive on virus-infected plants after 42 days. The survival on diseased asters was practically identical with the survival on corn plants but no eggs were deposited in the aster plants. In subsequent tests *D. maidis*, after five weeks on infected asters, were successfully maintained on healthy asters. Adults and nymphs of a related leafhopper, *D. elimatus* (Ball), with a limited host range identical to that of *D. maidis*, were found to survive well on asters carrying virus, but died rapidly on healthy asters. Maramorosch interprets his experiments as indicating that the virus altered the chemical composition of the aster plant in the direction of more adequate nutrition for the leafhoppers which, in the case of *D. maidis*, became sufficiently adapted to aster as to permit survival even on virus-free asters.

Among the species discussed by Severin (1946) in his report on the longevity of leafhoppers on virus-infected and healthy plants was *Texananus spatulatus* Van Duzee. He stated that individuals of this species which transmitted aster yellows virus lived longer than those which failed to transmit virus. Only a small part of the data on which this conclusion was based has been published (Severin, 1945). Since the virus transmitting efficiency of this species was exceedingly low (most individuals carrying virus infected less than one percent of the plants fed upon) and since it is not clear whether the transmitters and the non-transmitters were maintained in the same manner, further confirmation is needed for the generalization that the transmitting insects lived longer than the non-vectors. Severin construed the increased longevity to mean that the plants infected were better hosts and prolonged the life of the leafhoppers. However, since the insects were transferred daily to new test plants and transmitted virus to only a few plants this explanation does not seem feasible. If the transmitting insects lived significantly longer than non-transmitters, it would be evidence that the virus *per se* was beneficial to the insect.

No reports, parallel to those given for plant viruses, have been found to indicate that animal viruses may render their hosts suitable as food sources for arthropods if, in the absence of virus, such hosts are unacceptable to the arthropod species. Virus-infected animals sometimes carry abnormally high populations of arthropod parasites but apparently this is only because such animals become

debilitated and therefore are less capable of ridding themselves of the parasites than are healthy individuals.

In none of the situations just described was it suggested by the research workers involved that the virus itself contributed directly to the increased longevity of the insect vector.

A Virus Harmful to Both Animal and Plant

Although there have been many insect-borne plant viruses known and a less lengthy list of insect-borne animal viruses, until recently there has been no report of a virus that was harmful to its insect vector.

It is true that we have such an example among the rickettsiae, some of which have also been called viruses, but Snyder (1948) classes these as "micro-organisms . . . intermediate in characteristic between bacteria and viruses . . ." The body louse, vector of typhus fever rickettsiae, is also killed by the infectious agent it carries. Zinsser (1935), describes the plight of the body louse in these words: "The louse shares with us the misfortune of being prey to the typhus virus. If lice can dread, the nightmare of their lives is the fear of some day inhabiting an infected rat or human being. For the host may survive; but the ill-starred louse that sticks his haustellum through an infected skin, and imbides the loathsome virus with his nourishment, is doomed beyond succor. In eight days he sickens, in ten days he is *in extremis*, on the eleventh or twelfth his tiny body turns red with blood extravasated from his bowel, and he gives up his little ghost."

The first indication that a plant virus could cause tissue changes in its insect vector was given by Littau and Maramorosch (1956). They reported that aster yellows virus caused a higher percentage of fat body cells to have stellate nuclei than occurred in virus-free *Macrosteles fascifrons* (Stål). There is as yet, however, no evidence that these effects are harmful to the leafhopper.

The effect of aster yellows virus on the longevity of this vector was tested extensively by Severin (1947). Both infective and non-infective leafhoppers were held on Sacramento barley, which is immune to the virus, and survival was recorded. Adult longevity ranged from approximately 30 days to over 140 days. The 350 infective leafhoppers survived as long as did an equal number of non-viruliferous individuals. He concluded that the virus itself is neither beneficial nor injurious to adult aster leafhoppers.

A report from Japan (Yoshii and Kiso, 1957), indicates that

in several respects the virus causing dwarf disease of orange alters the metabolism of infected orange leaves and the metabolism of the plant hopper vector, *Geisha distinctissima* Wal., in a similar manner. For example, oxygen consumption and total phosphorus were reduced in both host plant and vector. The publication does not indicate whether or not these metabolic disturbances adversely affected the infective insects in a way that was reflected in reduced longevity, reproduction or activity.

Recently we have been able to demonstrate that the most important stone fruit virus in western North America, Western X-disease virus, causes the premature death of at least one of its leafhopper vectors.

Colladonus montanus (Van Duzee) had proved to be an exceedingly inefficient vector of the virus from peach to peach. However, after the discovery that celery is also a susceptible plant host of the virus (Jensen, 1956), *C. montanus* was retested using celery as the virus source. From these experiments it was determined that *C. montanus* readily acquires the virus from celery. Groups of leafhoppers, fed alternately on a series of healthy peach and celery plants, transmitted virus to 57 of 213 celery plants but to only four of 238 peach trees (Jensen, 1957). Because of the superiority of celery over peach as both a virus source and a test plant and because *C. montanus* lives well on celery but dies rapidly on peach, experiments comparing the longevity of viruliferous and non-viruliferous leafhoppers were carried out on celery. Longevity was measured from the first day on test plants which was after completion of the average latent period of the virus in the vector.

The experiments, reported elsewhere (Jensen, 1958; 1959), show that Western X-disease virus itself causes the premature death of its insect vector. The leafhoppers which did not transmit virus survived on the test plants approximately twice as long as did the transmitters. The increased mortality was not due to altered plant nutrition, because in many of the tests all insects, both transmitters and non-transmitters, fed together on the same virus source plants. The single variable was whether or not a given individual happened to acquire virus from the diseased plant upon which all had fed.

Moreover, an alternative explanation cannot be found in inherent differences between individual leafhoppers. The percentage of insects proving to be infective was usually directly proportional to the access time on the inoculum plant. Thus, in one experiment

insects from the same stock colony were caged on a diseased plant and removed from the plant as three different groups each with a different acquisition feeding time. Of those removed after three days, 27 per cent transmitted virus. After seven days, 70 per cent transmitted and after 16 days 90 per cent transmitted virus. In each group, longevity was greatest among the non-transmitters.

Multiplication of Virus in Insect Vectors

Multiplication of persistent viruses in their aphid vectors has not yet been demonstrated conclusively. Day (1955) reported experiments which suggested to him that potato leaf roll virus multiplies in the aphid *Myzus persicae*. However, Harrison (1958) found that infectivity and retention of this virus by *M. persicae* increased with feeding time on a virus source and that aphids gradually lost their virus on immune hosts. He concluded that the virus does not multiply in the aphid.

It has now been well-established that four plant viruses do multiply in their leafhopper vectors as well as in their plant hosts. These are the viruses of rice stunt, clover club-leaf, aster yellows and wound tumor.

Fukushi (1939) demonstrated that rice stunt virus is transmitted transovarially by its vector *Nephotettix apicalis* Motschulsky var. *cincticeps* Uhler. Starting with a single infective female, the experiment was carried through six leafhopper generations over a period of 374 days. At the end of the experiment there was no evidence of a decline in the number of insects per generation becoming infective nor in the percentage of plants infected.

Black (1950) carried out an experiment, similar to that of Fukushi, with clover club-leaf virus and its vector *Agalliopsis novella* (Say). Starting with a single viruliferous female, Black maintained the insects for five years and through 21 generations on alfalfa which is immune to the virus. At the end of this period there was no reduction in virus infectivity in the insects. If there was no multiplication in the insects the virus would have to retain its infectivity at a dilution conservatively estimated to exceed $1: 2.8 \times 10^{26}$. This is far beyond the dilution tolerance of the virus and means that the virus multiplies in the vector.

Occasional transmission of plant virus through the egg of the insect vector has also been reported by Black (1953) for wound-tumor virus and potato yellow dwarf virus in their respective vectors, *Agalliopsis novella* and *Agallia constricta* Van Duzee. Also,

Grylls (1954) reported that rugose leaf curl virus is transmitted through the egg of its leafhopper vector, *Austroagallia torrida* Evans. It is not yet known whether these viruses can persist in their vectors generation after generation, as has been demonstrated for the viruses causing rice stunt and clover club leaf, without being replenished by feeding on a diseased plant.

That aster yellows virus (Black, 1941; Maramorosch, 1952) and wound tumor virus (Black & Brakke, 1952) multiply in their respective leafhopper vectors has been shown by serial passage of the viruses through their vectors. Diluted virus was injected mechanically into the bodies of the vectors. Later, virus was recovered from the same insects, diluted, and injected into fresh leafhoppers. Ten such serial passages were made with aster yellows virus and seven with wound tumor virus, yet the concentration of virus in the insects attained as high a level in the last passages as in the first. In the absence of multiplication one would have to postulate a dilutions of 10^{-40} for aster yellows virus and 10^{-18} for wound tumor virus.

It is probable that among the many other leafhopper transmitted viruses, especially those having long incubation periods in the vector, will be found additional plant viruses which also multiply in insects. However, it should not be assumed that all leafhopper vectors are also virus hosts. Freitag (1936) and Bennett and Wallace (1938) have presented strong evidence that curly top virus of sugar beets does not multiply in the beet leafhopper, *Circulifer tenellus* (Baker). It should be added, however, that this virus has a very short (approximately 24 hours) incubation period in the vector.

Virus Origin

After tobacco mosaic virus was purified and shown to be a crystalline protein (Stanley, 1935), viruses were considered by some to be unrelated to living organisms. It was suggested that plant viruses originated first from plant cell components and secondarily developed the broad spectrum of specialization which ranges from little or no dependence upon insect vectors, such as in the case with tobacco mosaic virus, up to the leafhopper transmitted viruses, most of which require insects for their dissemination.

In opposition to this idea, is the organismal theory of virus origin proposed by Green (1935) and supported by Laidlaw

(1938), Andrewes (1952) and others. According to this view viruses originated by retrograde evolution from parasitic microorganisms possibly akin to protozoa and bacteria. The fact that we now have several viruses which multiply in animals (insects) as well as in plants has brought into greater prominence the organismal theory of virus origin, and has resulted in its extension (Maramorosch, 1954) to suggest that plant viruses were originally arthropod viruses.

Viruses had been observed to cause disease symptoms in the plant hosts, but not in the insect vectors. Until plant viruses were demonstrated to multiply in the insect vector, their association with insects had been considered somewhat fortuitous. However, with the knowledge that some insects are hosts and not merely vectors of these viruses the way was open to new interpretations as to virus origin.

Among the widely held generalizations in biology is one stating that those parasite relationships which are characterized by severe damage to the host are of relatively recent origin whereas those in which the parasite lives at the expense of the host but causes the latter little or no damage are of much greater antiquity. Thus plant hosts, such as those of aster yellows virus, which suffer extreme damage, would be considered recently acquired hosts. The leafhoppers in which this virus also multiplies without apparent harm would be considered primitive hosts. Andrewes (1957) has reviewed this subject extensively and suggests that arthropods may have been the original hosts not only of the insect viruses, but also of viruses commonly associated with plants and with vertebrates. Insects play a critical role in all three of these general groups of viruses. Originally viruses may have had insects as their only hosts. Later the viruses may have made use of vertebrates and plants to get from one insect to another. Lest we become too carried away by this argument, however, it should be pointed out that in the host range of some plant viruses and some vertebrate viruses there are species which are as symptomless as are the vectors which transmit the viruses. Nonetheless, this does not invalidate the theory. It merely means that such viruses may have been associated with the symptomless hosts much longer than with those still suffering damage. Andrewes (1957) points out that epidemics of yellow fever disease occur in South American monkeys but not in African monkeys. The virus appears to be

harmless to African monkeys and for this reason it may be inferred that the virus has existed in Africa much longer than in the New World.

Similar examples occur among plant viruses. The virus causing Pierce's disease in grapes is probably of New World origin because its effect on the native American species of *Vitis* is mild whereas it is lethal to the introduced *Vitis vinifera* Linnaeus, the grape of history, which is considered to be native from southeastern Europe to western India. Also in America is a long list of apparently symptomless host plants of Pierce's disease virus, ranging from grasses to woody shrubs. Moreover, in America are many species and high populations of "sharpshooters," the leafhopper vectors of Pierce's disease virus. This group of leafhoppers is almost without representation in Europe.

The recent discovery of a plant virus which causes harm to its insect vector adds support to the theory of an insect origin of plant viruses. It provides more conclusive evidence that certain plant viruses are also animal viruses. Moreover, it supplies a concrete example of one stage in the postulated evolution of a virus which until now existed only in theory. It may even raise a doubt, however microscopic, regarding the validity of one of our oldest generalizations in virology, namely, that humans and other vertebrates are immune to injury by plant viruses.

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PYRAMIDOBELA ANGELARUM KEIFER ON ORNAMENTAL BUDDLEIA IN THE SAN FRANCISCO BAY AREA

(Lepidoptera: Ethmiidae)

Pyramidobela angelarum was described in 1936[1] from southern California. Specimens had been reared in Los Angeles, Santa Ana, and Santa Paula from various introduced species of *Buddleia,* and Keifer presumed that the moth had moved into the area from a more tropical region. The species was believed to breed continuously throughout the year, larvae having been collected in April, July, and October.

In recent years the species has apparently become established around the San Francisco Bay area, our first record having been an infestation at San Bruno, San Mateo County in May 1949. During the last four years adults have been taken at lights in Berkeley, Alameda County, in October, December, February, and April (Powell, J. R. Powers, G. I. Stage) and in Pleasant Hill, Contra Costa County, in May (P. A. Opler).—A. E. PRITCHARD and J. A. POWELL, *University of California, Berkeley.*

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THE 1958 MIGRATION OF THE PAINTED LADY BUTTERFLY, VANESSA CARDUI (LINNAEUS), IN CALIFORNIA

(Lepidoptera: Nymphalidae)

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The most recent migration of the painted lady butterfly, *Vanessa cardui* (Linnaeus), was particularly notable for its long duration, from November, 1957 through May, 1958. Observations on this migration have yielded rather definite information on several doubtful points and are the subject of this paper.

The previous reports by the present author on the migration of this species (Abbott, 1950, 1951), based on the migrations of 1924, 1926, 1941, 1945, and 1949, determined various points which will be referred to here only incidentally. It became apparent from these studies that the breeding area of this species, in non-migration years, is chiefly, if not entirely, south of the California-Mexico border, probably in both Baja California and Sonora. Comparatively few of the butterflies are found in California in a non-migration year, and these few chiefly in the Colorado Desert. In a migration year the number emerging in these breeding areas is presumably much greater. One result is a very visible diurnal migration, in a generally north-northwest direction, covering southern California and in some years north to the San Francisco Bay region. Yet the final eggs laid in these regions where it is an immigrant fail to result in a permanent occupation of this more northern habitat.

As in the preceding studies, the present report results from a cooperative study; in this case with the added advantage that most of the contributors are professional entomologists. Thanks to the continued interest of R. F. Smith in collecting data for the project, valuable contributions were secured from the following members of the staff of the Department of Entomology and Parasitology, University of California, Berkeley: P. D. Hurd, Jr., E. G. Linsley, J. W. MacSwain, R. F. Smith, W. E. Ferguson, J. A. Powell and from the following members of the Agricultural Extension Service: G. Beards, J. Dibble, R. Emparin, G. L. Smith, J. E. Swift. I am also indebted to R. C. Dickson of the Citrus Experiment Station, University of California, Riverside, and G. D. Peterson, Jr., Farm Adviser for Imperial County, for descriptions of the winter and early spring invasion of the

Colorado Desert, and to C. E. Strickler, Park Supervisor, and D. E. Merkel, State Park Naturalist, for data for the entire season from Anza-Borrego State Park. L. M. Martin of the Los Angeles County Museum has been helpful with both data and criticisms. Credit for individual contributions will be indicated in the text. It should be understood that the author alone is responsible for the conclusions drawn from the data.

The present status of our knowledge of insect migration in general and of Lepidoptera in particular is summarized in two recent papers by Williams (1949, 1957). The word "migration" is defined by Williams (1949) as "a change of location which is determined both in distance and direction by the insect itself, and not a passive distribution of individuals by overpowering forces such as strong winds."

The present year, 1958, has presented a picture of a longer continuing migration than any other in recent years. The season was mild, with early rainfall resulting in extensive desert vegetation. Butterflies of this species emerged very early in their normal breeding areas in northern Mexico in such numbers as to result in migration. Numbers of them had already reached the southern part of Anza-Borrego State Park by November, 1957 (Merkel), and Imperial Valley by late December (Peterson). Peterson wrote: "As near as I could determine from actual flight observations plus population density counts, the butterflies seemed to be migrating generally from the desert areas south and east of Imperial County and toward the north and northwest."

Dickson wrote: "I first noticed the migration of painted lady butterflies about the last week of January or possibly the week before that. About that time I heard that automobiles coming into Holtville from Yuma had the radiators practically clogged by these butterflies. They were moving out of Sonora, flying northwest to west, and more particularly numerous near Carpinteria. . .

"The painted ladies have laid eggs on suitable host plants (particularly *Cryptantha* and *Malva*) all over the deserts and desert valleys. Large numbers of larvae are now (March 17) feeding on these plants all over the Colorado Desert so that this area may be a source of a later flight this season."

The emergence of second generation adults from these metamorphosed larvae was recorded in February in Imperial County

by Peterson, who concluded that they joined the general migration which had been proceeding without interruption, and in Borrego State Park by Merkel, who described increasing large swarms somewhat farther north than the November–December emergence, but did not observe the actual migration.

The height of the migration in the valleys of southern California was in late February and early March. Under date of March 17, Dickson wrote: "There has been some flight through Riverside the past three weeks, but greater numbers flew through Beaumont, Redlands, and Colton. Presumably others flew over the Mojave Desert since I hear that some have reached the San Joaquin Valley. I did not see any flight this week either on the desert or in Riverside. This might indicate that the flight is over for this year, or only that the cold weather has slowed emergence of new butterflies in their areas of origin." During this period the "Redlands Facts" reported that "endless swarms" were flying through Redlands.

The "Los Angeles Times" reported on March 5 and 6 that a "great invasion" had occurred in the Los Angeles area March 2–4. Particular mention was made of Hollywood, the Hollywood hills, and the San Fernando and San Gabriel Valleys. The author observed that they were still common at San Fernando, although not in "millions," on March 18 and 19. Many of them were stopping to feed on wild radish flowers in vacant lots, before continuing their flight to the north-northwest.

The western edge of this February–March migration was recorded by the author at Redondo Beach. Individual *V. cardui* were observed on garden flowers on January 4, 16, February 5, 19, 26, 27, March 9, 29; actual migrating butterflies were observed February 21, daily March 1–6, 11, 16. The migration was steady March 2–4, one or two per minute, the same days as the maximum in Los Angeles.

After an interval in late March and early April, which was marked by cold and rainy weather, a heavy migration wave occurred in the middle of April in the San Joaquin and Salinas Valleys. Summarized in brief:

San Joaquin Valley.—Heavy migration throughout valley from south and east of Bakersfield to the region west and north of Tracy. First flight recorded April 8, at height April 10, 11, began to decline April 17, moderate flight April 20, a few stragglers

April 23 (R. F. Smith, Hurd, Linsley, MacSwain, Ferguson). Stragglers to May 9 (R. F. Smith, Swift).

On April 13 they were abundant near Mt. Diablo (R. F. Smith). On April 20 there was a heavy flight in the Walnut Creek region (R. F. Smith, Swift).

Salinas Valley, April 17.—Migration reported (Dibble, Emparin).

The author made one observation of three migrants at Redondo Beach on April 19, but has no other report of this third generation from the Los Angeles area.

Larvae, presumably from eggs laid by these April migrants, were so abundant in the San Joaquin and Salinas Valleys from about April 20 to May 9 that they were found not only on wild plants, but damaging alfalfa, lettuce, and other crops (R. F. Smith, Swift). They were also abundant in clover fields in Glenn County, farther north (reported by R. F. Smith). At Shafter, near the southern end of San Joaquin Valley, the larvae were abundant from about April 10, and in some cases caused enough damage to cotton fields to require control measures (G. L. Smith, Beards).

The above description shows an apparent pattern of a built-up migration through three generations rapidly succeeding each other. Most published descriptions of former spring migrations of this species have assumed that the migrating adults were all of one generation and in general from a common source. This has applied not only to migrations in California and Utah, but also to those in Europe. Campbell (1924) in California and Woodbury *et al.* (1942) in Utah described egg-laying along the way, with the possibility that a new generation from these eggs took part in a later migration the same year. It has, however, seemed more usual that the larvae from these eggs either did not develop to the adult stage, or, because of the smaller numbers, their presence or possible later flight went unnoticed, except in rare instances.

The interpretation of numbers of generations involved is complicated by the apparent great variation in the length of the egg, larva, and pupa stages. L. M. Martin, after checking the literature, wrote me (June 19, 1958): "As far as I can find out, there are no figures on the length of these stages. We know that they vary, for instance, in the egg stage from 7–60 days. The

larval stage varies from 13–41 days and the pupae have been known to stay in that stage for eight months."

The most distinct three generation pattern is found in the records of D. E. Merkel, State Park Naturalist at the Anza-Borrego State Park. As a background, Merkel notes that in the period 1956–57, prior to November 1, 1957, no painted ladies were observed in the park. "If any were present, they were in such small numbers as not to attract attention." This appears to eliminate the Park as part of the breeding area in non-migration years.

As the earliest record of the 1958 migration, large swarms were first noted in November, 1957, in the Mud Hills region in the southern part of the Park. They had apparently emerged farther south, probably in northern Mexico, and had flown north to this secondary breeding area. The subsequent history is as follows: January, 1958, in same Mud Hills region, many pupal casts. February, 1958, at Borrego Campground area, about 25 miles farther north, increasing large swarms of adults. March, 1958. Larvae numerous throughout Borrego Valley, some beginning to pupate. April, 1958. Adults numerous in valley. Empty pupal cases abundant, probably of this species (also noted by Ferguson).

The above summary shows at least three generations. The November generation probably came from last year's eggs in the normal breeding area in northern Mexico, following a long pupal stage during the summer and fall. The second began to emerge in late January, reaching a maximum in February, and the third began to emerge in late March, reaching a maximum in April.

The first and second of these generations were also observed by Peterson in Imperial Valley. He recorded a steady migration from about December 20, lasting six or eight weeks, corresponding to the November and February periods of adult abundance reported by Merkel. Peterson thinks it is probable that two generations of larvae were abundant on desert hosts (mainly *Cryptantha* spp.) during this period, although, because of continuous migration, he could not separate them. "There may have been an extremely small third generation in the cultivated area of Imperial Valley, but this is in doubt." The decrease in numbers could have been caused by most of the second generation adults

migrating before egg laying, or by a drying up of the food-plants of the second generation larvae, or, as Peterson suggests, parasitism of the larvae may slow down the numbers of each successive generation.

The timing suggests that these second generation migrants are those reported as numerous through the San Gorgonio Pass and San Bernardino Valley regions in February and which were numerous in the Los Angeles region in early March. These reached the San Joaquin Valley, laid eggs, and from the eggs came the very abundant migrants observed throughout the valley in the middle of April. (Linsley and MacBride noted that these migrants seemed to be nearly all fresh specimens). Also belonging to this same third generation were those reported from Salinas Valley April 17, Mt. Diablo April 13, and Walnut Creek April 20.

It is not so easy to interpret the observations made in the desert in April, but the time element is again used. The names of the observers are given, the assignment to generations is by the author.

Colorado Desert, 18 miles west of Blythe, April 14–18.—Enormous numbers of hatched and parasitized pupae (eggs laid by second generation). Few adults left (Hurd, Powell). Most of the adults which had emerged must have flown north-northwest (third generation).

Borrego Desert, April 11–18.—Emerged pupae (eggs laid by second generation) abundant. Adults abundant, but not seen to be migrating (third generation) (Ferguson, Merkel).

Eastern Mojave Desert, April 12, near Amboy.—Pupae abundant, not emerged (eggs laid by second generation). Some worn adults, which had probably flown from farther south. A few adults near Topock, Arizona April 14 (Linsley, MacSwain).

Western Mojave Desert, April 12, 13, 14, 19.—Mature larvae abundant (eggs laid by second generation). Some adults migrating (third generation) (Hurd, Powell, Linsley, MacSwain).

These interpretations as to the principal generations involved do not eliminate the probability that some members of each generation flew farther than the ones here described, either before depositing eggs or afterwards. The timing best fits the basic interpretation here given, but there is probability of an overlapping of generations in each locality.

The larvae from eggs laid by the third generation were those

found so abundant in the San Joaquin and Salinas Valleys from about April 20 to May 9 that they were transferring from weeds to vegetables. Larvae found at the same time in Glenn County showed that adults of the third generation had reached there. This appears to show that it was the third generation larvae which were in such numbers as to be considered destructive, although it may be because these reports were from regions which have extensive field crops.

Reports of a fourth generation and on the final extent of the 1958 migration are fragmentary. J. A. and F. C. Powell collected *V. cardui* in Siskiyou and Del Norte Counties on seven scattered dates between June 23 and August 29, while G. Pitman found them on September 12, also in Siskiyou County. Specimens appeared fresh on June 24, 26, July 9, 18, August 4. This suggests continuation of the migration to the Oregon border and at least a fourth generation.

Based on preceding years of observation, it may be predicted that there will be no increase in resident population of *V. cardui* in 1959 in the regions invaded. The population control is discussed below under parasitism of larvae.

The butterfly *Vanessa cardui* (Linnaeus) received its specific name from the thistle, and is commonly thought to lay its eggs chiefly on thistles. But in California, where thistles are not particularly abundant, other plants appear to be just as acceptable as food plants for the larvae. This year's observations emphasize a number of these, as follows:

Colorado Desert: *Cryptantha* spp. (Peterson).
Colorado Desert: *Cryptantha, Malva* (Dickson).
Mojave Desert: *Cryptantha, Amsinckia, Phacelia* (Hurd, Powell).
Mojave Desert: *Cryptantha*, lupine, mallow (Linsley, MacSwain).
San Joaquin Valley: *Amsinckia.* Alfalfa, lettuce, and other crops (Swift).
San Joaquin Valley: *Malva, Amsinckia,* sunflowers, weeds, cotton (G. L. Smith, Beards).
Glenn County: Yellow star thistle, *Amsinckia,* dock (reported by R. F. Smith).
Salinas Valley: Nettle, lettuce (reported by R. F. Smith).

This shows that a considerable variety of wild plants are utilized and that in a year of special abundance, cultivated crops may be attacked. This favors large succeeding generations in the same year and continuation of migration.

The causes of a population increase resulting in a heavy

migration have already been enumerated to include a mild winter, a large amount of rainfall, and consequent abundant desert vegetation. In addition, in 1958, an unusually long favorable season has resulted in a build-up of population through at least three generations in one spring, with migration occurring in all of them. Yet it is almost an axiom that such a migration does not result in colonizing new areas or in increasing the permanent population in the areas reached. Possible checks are too rigorous a winter climate, effective toward the north, drying up of the food plants on which eggs are laid, effective toward the south and in arid climates, and control by parasitic attack. This last point will be discussed further.

Elton (1927), after extensive studies of population control, concluded that the most effective end of an outbreak or plague, whether resulting in a migration or not, is caused by some form of parasitic attack.

Schrader (1928) emphasized that *Vanassa cardui* (L.) is subject to the attacks of "a considerable number of parasitic wasps and flies." Essig (1926) in his section on Tachinid flies, names three species, *Zenillia blanda, Frontina archippivora,* and *Chaetogaedia monticola,* which have been reared from larvae of *V. cardui.* This statement in no way limits the number of possible parasites.

The prevalence of parasitism is shown by several of this year's reports, as follows.

"Adult emergence within (Imperial County) was much less than would appear to be indicated by the larval populations present on the desert. This was undoubtedly due to the high rate of parasitization by both insects (Tachinidae) and entomophthorous fungi." (Letter from G. D. Peterson, Jr., May 19, 1958.)

"At Topock, Arizona, on April 14 we observed relatively few butterflies but enormous numbers of Chalcid wasps which had apparently emerged in that area. These wasps were congregated around a creosote bush and several thousand were taken in a single swing of the net." (Letter from J. W. MacSwain, May 23, 1958.) The possibility is suggested that many of these may have emerged from *V. cardui* larvae and may account for the small number of adults observed.

". . . enormous numbers of hatched and parasitized pupae present at the 18 miles west of Blythe locality in late April. The

few adults present could be stragglers, late emergences, etc., which had not gone farther north yet." (Letter from J. A. Powell, May 19, 1958.)

The fact that the direction of flight of migrating *V. cardui* through California is mostly toward the north-northwest and directly against the prevailing wind has been generally observed in all the migrations on record. In the 1958 reports, this was emphasized by Dickson and Peterson in the Colorado Desert, by Dickson in describing the course taken through southern California, by Linsley, MacSwain, and Ferguson in the San Joaquin Valley, and by R. F. Smith and Swift in the Walnut Creek region. The most important variant was in the San Joaquin Valley on April 20, when the majority were flying northwest near Merced, mostly west Merced to Tracy, and mostly north west of Tracy (Linsley and MacSwain). It was not reported whether there was any difference in the wind direction between the regions just enumerated.

The author made a few observations on the direction of flight of 1958 migrants at Redondo Beach, about 1000 feet back from the ocean front. As the migrants came over singly, it was possible to follow the flight of individual butterflies. Variable winds are normal at Redondo Beach. The beach faces the west and the fair weather winds vary from northwest to southwest and on any day constantly fluctuate. The early morning winds are usually northeast, and on days of desert winds there may be northeast gusts all day. Because of the very small numbers of butterflies recorded, any conclusions as to the effect of direction of wind on direction of flight are very tentative. There was an observed tendency of butterflies to fly into the northeast wind in the morning (observed on five mornings at varying times from 7:45 to 11:20), and for the flight to be chiefly northwest, but varying slightly toward the north, during the afternoon. The limited observations support the former observations that flight, whether individual or mass, is usually straight into the wind, with little individual variation (Abbott, 1951).

A survey of collected information on the migration of *Vanessa cardui* (L.) in North America points to its classification as a unidirectional flight with no return (Williams, 1930, 1938, Abbott, 1951). Study of it in California has the special advantage that the compass direction of flight is clearly seen, the same prevailing direction occurs in every migration year, and the numbers in-

volved are great enough to insure the accuracy of these two statements.

The fact that years of general migration occur at intervals, four years more or less, supports the theory that migration occurs only when a population has been built up to what Chapman (1939) calls "outbreak proportions." Chapman describes this as resulting from a relaxation of environmental resistance. This might occur and take effect all in one generation, or it could be cumulative in result, reaching outbreak proportions after a series of generations. The occurrence of migrations at irregular intervals of years favors the cumulative interpretation, whereas a great migration in a year which is particularly favorable from an environmental standpoint indicates that it might occur in one generation.

Observations on the 1958 migration suggest another kind of cumulative result, namely, pressure of population and resulting migration continued through three generations, all of them developed under exceptionally favorable conditions. It may also be emphasized that larvae of the third generation were so numerous as to be destructive of cultivated crops.

In the reports of former years (Abbott, 1950, 1951) it was noted that the migration was in a series of waves of abundance, particularly in 1926 and 1941. It was interpreted that the flight was periodically slowed down by unfavorable weather. No data were available to show a succession of generations. Both factors were apparently involved in the 1958 season. The weather might affect metamorphosis of larvae as well as flight of adults.

Migration is only one of the results of an excessive increase in population, and why it affects only certain species has not been determined. It may be mentioned that Williams, after collecting all available information on migration of Lepidoptera, concludes that there are many more migratory species than the most abundant and conspicuous ones which are well known. He states (Williams, 1949): "We have evidence today of migration in two or three hundred species of butterflies from almost all parts of the world. In about fifty of these there is a considerable weight of evidence which makes it almost impossible to accept any other explanation." In another reference (Williams, 1957) he states that 20 or 30 migrant species are known from the United States.

SUMMARY

(1) The migration of the painted lady butterfly, *Vanessa*

cardui (L.), in California in the spring of 1958 was exceptional in its duration from November, 1957 to May, 1958, as well as in the great numbers of individual butterflies involved.

(2) The north-northwestward distribution during the period was gradual and was correlated with the development of three generations. The first generation invaded the Colorado Desert from northern Mexico from November, 1957 to January, 1958. The second generation emerged on the Colorado Desert from eggs laid by the first generation and flew north in February and early March through the San Bernardino Valley and the Los Angeles area to the Mojave Desert and the San Joaquin Valley. The third generation, emerging in the two last named regions, but chiefly in the San Joaquin Valley, resulted in a great flight through the San Joaquin and Salinas Valleys in the middle of April. The large number of larvae resulting from this third wave of the flight attacked various field crops.

(3) The continuance of a migatory flight through successive generations is favored by the fact that several widely distributed food plants serve as food for the larvae. This applies to both wild and cultivated plants.

(4) Extensive parasitism during the larval and pupal stages was noted by several observers in both the Colorado and Mojave Deserts. This furnished evidence toward the theory of Elton (1927) that parasitic attack is the most important control of an insect outbreak, whether or not accompanied by migration.

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TWO NEW RECORDS FOR THE CONE BEETLE GENUS CONOPHTHORUS HOPKINS IN CALIFORNIA

(Coleoptera: Scolytidae)

During the summer of 1956, a collection of cones of the western white pine, *Pinus monticola* Douglas was made in the Lassen Volcanic National Park area, Lassen County. Two specimens of *Conophthorus monticolae* Hopkins were reared from one of the cones. This species of cone beetle has been previously known only from the cones of the western white pine in Idaho, Washington and Canada (Keen 1958)[1]. During the same summer and following summers, collections of cones of the lodgepole pine, *Pinus contorta* var. *latifolia* S. Wats were made from several locations in the Sierra Nevada mountains. In Calaveras and Tuolumne Counties, the cones of this pine were found to be heavily infested with *Conophthorus contortae* Hopkins. Until now, this species has only been recorded from the cones of the shore pine, *Pinus contorta* var. *contorta* S. Wats near Newport, Oregon (Keen 1958). The author is indebted to Dr. S. L. Wood of Brigham Young University in Provo, Utah for the identification of these beetles.—HERBERT RUCKES, JR., *University of California, Berkeley.*[2]

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1 Keen, F. P., 1958—Cone and Seed Insects of western forest trees. U.S.D.A. Technical Bulletin No. 1169. pp. 48 & 55.

2 Studies of the cone and seed insect problems of the pines in California made possible by a grant from the Gilbert M. Walker Fund.

NOTES ON MORIUS OCCIDENS CASEY WITH A DESCRIPTION OF THE MALE

(Coleoptera: Pselaphidae)

ROBERT O. SCHUSTER

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On the basis of a unique female, broken into many parts, Thomas L. Casey described *Morius occidens* in 1893. Casey's description is to be found in Bowman's Pselaphidae of North America and the genus is keyed into the North American pselaphid fauna by Park (1953). The male has not previously been described.

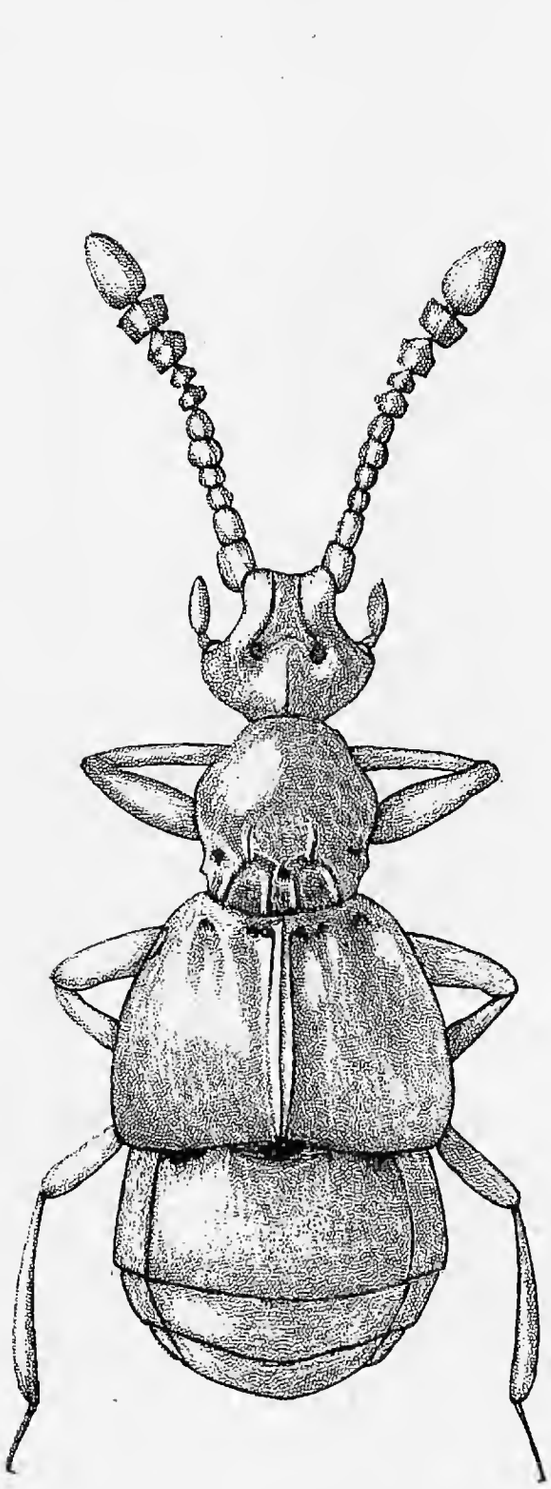
The genera *Morius* and *Rhinoscepsis* are the only North American representatives of the subtribe Rhinoscepsina, tribe Euplectini. *Morius* was previously known only from the type collected in Santa Cruz County, California.

What appears to be one species of *Morius* has been recovered at a low frequency from leaf mold in the Coast Range from Monterey to Mendocino Counties in California. The number of specimens in the series now available for study is insufficient to determine the nature of variation, mainly color and degree of pubescence. The male is associated with Casey's female because (1) it is the predominant form recovered in Santa Cruz County, (2) it is of the proper size and color, and (3) it agrees with the type except for the male sexual characters. (Comparison with the type, which I have not seen, was made by Gordon A. Marsh.)

Casey's original description was good, and only a few characters, mainly of the mouth parts of the female, and those pertaining to the male are described here.

MORIUS OCCIDENS Casey

Additions to description of female. Head as in Casey's description but with weak median carina extending from neck to about the vertexal foveae. Labrum straight across the front, rounded at lateral margins; 2 cone-shaped structures occur medially on lower front margin and 5 or 6 in a row behind the first 2; 4 macrosetae arise laterally, 1 on the dorsal surface and 3 ventrally. Mandibles heavy, 6 teeth on each inner ramus; 1 lamellate seta occurs midway on the dorsal surface along with a few smaller setae. Maxillary palpus with segment I small, 1/3 length of II; II thin for basal 1/2 and swollen at distal 1/2; III slightly more than 1/3 length of II and equally as wide; IV 3 times as long as III and noticably wider, terminated by a long, thin palpal cone almost 1/2 as long as segment IV; 2 specialized setae occur midway on outer surface. Abdomen of 5 visible tergites and 6 visible sternites. Tergite I with fovea formed by 2 apodemes at each



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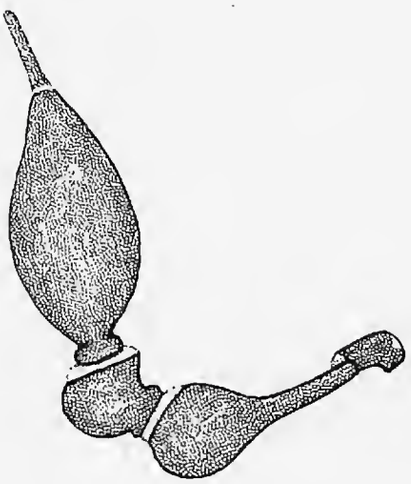

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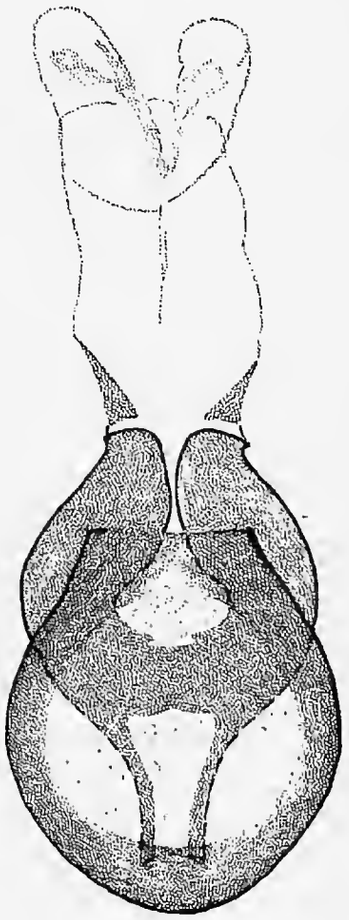

3

EXPLANATION OF FIGURES

Morius occidens: Fig. 1, adult male, dorsal aspect; Fig. 2, maxillary palpus; Fig. 3, aedeagus, dorsal aspect.

anterio-lateral margin and a large pubescent excavation occupying the median 1/3; II with a much smaller depression at the anterior margin; other tergites simple; sternite I entire behind coxal lines although this condition is obscured by pubescence on point-mounted specimens; II 3 times as long as I with a deep, pubescent, transverse sulcus at the front margin. Mesosternum with 2 carinae and 3 anterior pubescent foveae; mesocoxae narrowly separated, the coxal cavities confluent but nearly closed by processes of the meso- and metasterna; a large pubescent fovea occurs laterad and one posterior to each coxa; metacoxae contiguous.

Male.—As in the female with the exception of the abdominal tergites. Brachypterous males have been noted and fully winged populations may eventually be found. Six sternites are readily visible, and a seventh, a minute penal plate strongly attached to a genital segment and usually removed with the aedeagus during dissection, is sclerotized distally and may at times be visible externally. A small, semi-triangular projection occurs at the middle of the posterior margin of the third visible sternite. Male aedeagus 0.23 mm. long × 0.15 mm. wide; dorsal surface of capsule membranous, ventral surface mostly so, depending to some extent on the age of the individual; two parameres ventrally, extending to rear of capsule and bridged by wide connection at about 1/2 the length of the aedeagus; a membranous tube, apically bifid, is weakly sclerotized near the apex of each paramere and again at the terminal dichotomy; numerous small pores are present along the apical margin of the parameres and a number of fine setae occur along their lateral margins.

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FOURTH ANNUAL INSECT PHOTOGRAPHIC SALON

The Pacific Branch of the Entomological Society of America announces the fourth annual insect photographic salon to be held in conjunction with its meeting in Sacramento, June 23–25, 1959. Photographs will be judged in three categories: monochrome, color transparency, and color transparency sequence. Deadline for all entries is June 16, 1959. Entry blanks may be obtained from Dr. E. S. Ross, California Academy of Sciences, Golden Gate Park, San Francisco 18, California.

A FEW ODONATA FROM YOSEMITE

EDWARD J. KORMONDY

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A small collection of dragonflies taken in Yosemite National Park (Tuolumne County, California) and deposited in the University of Michigan Museum of Zoology has been determined by the author. The series was taken July 10–13, 1939, by fifteen children on a "nature hike," under the direction of C. L. Gibson, who gave the specimens to the Museum. The locales represented are Miguel Meadows and Sand Pit Lake in northwestern Yosemite, about two miles southeast of Lake Eleanor at an elevation of 5200 feet. According to Chief Park Ranger Elmer Fladmark *(in litt.*, December 9, 1958) there is no "Sand Pit" Lake at Yosemite and the excavation currently known as Gravel Lake may have had the former name at one time.

In the only collective report on California Odonata to date, Kennedy (1917) listed ten species as occurring in Yosemite:

Lestes dryas Kirby, *Enallagma cyathigerum* (Charpentier), *Amphiagrion abbreviatum* (Selys), *Aeshna interrupta nevadensis* Walker, *Cordulia shurteffi* Scudder, *Libellula pulchella* Drury, *Libellula quadrimaculata* Linnaeus, *Sympetrum semicinctum* (Say), *Leucorrhinia glacialis* Hagen, *Leucorrhinia hudsonica* (Selys).

The following list of fifteen species, none of which constitutes a new state record, includes eleven (indicated by an asterisk) reported from Yosemite for the first time (Sand Pit Lake and Miguel Meadows are abbreviated as SPL and MM respectively):

Lestes dryas Kirby, 5♂♂, 9♀♀, SPL and MM; *Enallagma cyathigerum* (Charpentier), 1♂, SPL; *Ischnura perparva* Selys*, 3♂♂, 2♀♀, SPL and MM; *Anax junius* (Drury)*, 2♂♂, SPL; *Aeshna palmata* Hagen*, 1♂, MM; *Aeshna multicolor* Hagen*, 1♂, SPL; *Libellula pulchella* Drury, 10♂♂, 1♀, SPL and MM; *Libellula quadrimaculata* Linnaeus, 12♂♂, MM; *Libellula saturata* Uhler*, 11♂♂, 1♀, SPL; *Sympetrum corruptum* (Hagen)*, 1♀, SPL; *Sympetrum madidum* (Hagen)*, 2♂♂, 1♀, SPL and MM; *Sympetrum occidentale californicum* Walker*, 1♀, MM; *Sympetrum pallipes* (Hagen)*, 1♂, 2♀♀, SPL and MM; *Leucorrhinia intacta* (Hagen)*, 1♂, 1♀, MM; *Tramea lacerata* Hagen*, 3♂♂, SPL.

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THE JAPYGIDAE OF NORTH AMERICA 1— PROVALLJAPYGINAE AND NANOJAPYX

LESLIE M. SMITH

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The subfamily Evalljapyginae is characterized by the five pectinate laminae of the lacinia and the bilateral asymmetry of the forceps, as well as other characters. Silvestri (1949) studied three specimens from the state of São Paulo, Brazil and noted that they possessed a falciform distal lamina on the lacinia and nearly bilaterally symmetrical forceps. He named this insect *Provalljapyx lanei* new genus and new species and placed it in the subfamily Evalljapyginae although it did not fit in the two characters mentioned. Paclt (1957) placed Silvestri's genus *Provalljapyx* as a synonym of *Evalljapyx* but, as indicated below, this is not justifiable.

In my collection are 63 specimens representing five species which I assign to the new genus *Nanojapyx*. This genus from California shows affiliation to Silvestri's genus *Provalljapyx* from Brazil. Neither of these genera can be placed logically in the subfamily Evalljapyginae. In my opinion they represent an evolutionary group between the Projapygidae and the Evalljapyginae, and I therefore place them in the new subfamily, Provalljapyginae. All of the Projapygidae known from the New World have plumose body setae and bilaterally symmetrical anal cerci which do not show sexual dimorphism. We may assume that the Projapygidae arose from a primitive campodeid by the shortening and thickening of the anal cerci, and later by the addition of stout spines mesad on the cerci as a defensive mechanism for protection against attack from the rear.

A further step in the evolution is represented by the Provalljapyginae wherein the anal cerci are modified into unsegmented forceps which are symmetrical and do not show sexual dimorphism. The final evolutionary step is exhibited by the Evalljapyginae wherein in the left forcep is different than the right forcep and the forceps of the male are different from those of the female. This line of evolution is also supported by anatomical features other than the forceps.

Provalljapyginae, new subfamily

Similar to the Evalljapginae except: antennae with 20 to 23 segments, distal lamina of lacinia falciform, styli each with a

single seta, tergite VII slightly lobed or bilobed, pleura VII not heavily sclerotized or projected to the rear, forceps approximately similar and without sexual dimorphism, length of body 2 to 4 mm.

Inasmuch as this subfamily is now known from eastern South America and western North America, it seems probable that a rich fauna exists in this group. They have undoubtedly been overlooked by earlier collectors because of their small size and, if seen, they were probably mistaken as nymphal stages of larger species.

Key to the Genera

1. Stylus with a single seta, distal lamina of lacinia falciform, forceps similar (Provalljapyginae) 2
– Stylus with two setate, distal lamina of lacinia pectinate, forceps not bilaterally symmetrical (Evalljapyginae) 3
2. Two large median teeth on each forcep, no other teeth or denticles, posterior seta on pleuron plumose, segment X tergite setae 4 + 1 + 4 ..... *Provalljapyx*
– Four or more similar teeth on each forcep, posterior seta on pleuron simple, segment X tergite plumose setae 3 + 3 ..... *Nanojapyx*
3. Setose frontal sinus ..... *Ctenjapyx*
– Without setose frontal sinus ..... *Evalljapyx*

Nanojapyx L. Smith, new genus

Type species: *Nanojapyx pagesi* L. Smith, new species.

Head.—Antenna with 22 ± 1 segments; vertex covered with a number of M[1] and a lesser number of m; distal half of antenna with segments showing two fairly regular rows of m, *a* a little more to the base than to the extremity of the segment, longer than m on the same segment; apical lamina of lacinia falciform, shorter than the other four, pectinate laminae. *Thorax.*—Pronotum 6 + 6 M, meso- and metanotum 7 to 9 + 7 to 9 M; legs, femora dorsal apex with two subequal small usually plumose setae and one simple seta in a line; tarsus with two ventral rows of spine-like setae, two or three setae per row. *Abdomen.*—Tergites with four to five irregular transverse rows of M, and fewer m, M with 6 ± 2 pinnulae; sternites with five irregular transverse rows of M and fewer m, M with 3 ± 2 pinnulae; tergite X with 3 + 3 plumose M between the carinae and a variable number of m; lateral subcoxal organs broad with about four to seven plumose sensory setae each, in a single row, and two or three irregular rows of distinct glandular setae; styli on segments I–VII, each with one mesad seta, approximately one-third as long as the stylus; abdominal pleura; anterior pleurite with two large setae, with the anterior one plumose;

1 Abbreviations: M — macrosetae, plumose; m — sub-macrosetae, usually simple but occasionally plumose, *a* — dorsal sense-seta on the fourth antennal segment; L 1, L 2, L 3, — first, second, and third pair of legs; A, B, C, D — anterior, second, third, and posterior rows of M on the abdominal sclerites; I-X — abdominal segments.

pleuron with three large setae, posterior one simple; forceps apparently symmetrical, differing only in number of teeth, teeth usually sharp pointed, not rounded denticles; all setae on forceps simple, except one or two basal; no sexual dimorphism in forceps.

This genus is close to the genus *Provalljapyx* but can be distinguished from it by the presence of four or more teeth on each forcep.

Nanojapyx pagesi L. Smith, new species

Female.—Head: antenna with 22 segments; segments 13 to 22 with all setae of same size, arranged in two transverse rows, about 16 setae in distal circle, and about 20 setae in basal cricle; segment IV circled with eight to ten larger setae anterior to *a*; labrum with 7 + 7 simple setae of various sizes; mandible with three fused teeth and a fourth, distinct, less heavily sclerotized, pointed tooth; first tooth (ventral) of mandible largest and recurved at tip; galea of maxilla with sclerotized thumb at apex of anterior lobe with five spatulate projections at tip of thumb; palpus with ten simple setae; lacinia heavily sclerotized, arcuate, lamina 1 a rod, shorter than lamina 2; laminae 2 to 5, typical combs; labium with numerous simple setae; labial palpi short, conical, with two long and one short simple setae; dorsum of head with about 24 + 24 setae, mostly all plumose. *Thorax.*—Pronotum with 6 + 6 M and 5 + 4 m; mesonotum, prescutum with 1 + 1 M and 1 + 1 m; scutum with 7 + 8 M and 7 + 7 m; metanotum with 8 + 9 M; legs short, setae at dorsal apex of femur, numbers 1 and 2 plumose, number 3 simple, number 3 longer than number 1, number 2 shortest; large ventral setae on tarsus in two rows of two setae each, tarsal claws simple sub-equal. *Abdomen.*—Tergite I: prescutum with 1 + 1 M and 1 + 1 m, scutum with 6 + 6 M and 6 + 6 m; sternite I—prescutum with 4 + 5 M, and no m, scutum A = 4 + 4 M, B = 2 + 2 M and 2 + 2 m, C = 4 + 4 M, D = 9 + 9M; lateral subcoxal organs with 7 + 7 M and numerous glandular setae arranged in two irregular rows; stylus simple, conical with slightly bulging base, one simple curved seta; tergite II, A = 4 + 4 M, B = 2 + 2 M, C = 2 M and 3 + 3 m alternating in row with M; segments III to VII inclusive similar to segment 2; six ventral setae associated with stylus VII, as illustrated, setae 1, 3, and 5 with 3 or 4 pinnulae, setae 2 and 4 present. Segment VIII width 0.16 mm, length 0.18 mm; tergite, A = 4 + 4 M and 1 + 1 m, B = 2 + 2 M and 1+ 1 m, C = 3 + 3 M and 3 + 3 m alternating in row with M; sternite, A = 3 + 3 M and 1 + 1 m, B = 3 + 3 M and 1 + 1 m, C = 3 + 3 M and 3 + 3 m; spermatheca between B and C, bulbous with a long anterior spike; genital opening with many simple setae, no palps. Segment IX tergite, 3 + 3 M and 3 + 3 m alternating; sternite with 3 + 3 M and 3 + 3 m; segment X, width 0.14 mm, length 0.20 mm; tergite, (between crenulae) A = 2 + 2 M, B = 1 + 1 M, C = 3 + 3 M of which the four mesad setae are simple, about six m scattered over the tergite; sternite A = 3 + 3 M followed by a row 2 + 2 m, B = 2 + 2 M and 1 + 1 m, C = 1 + 1 M, D = 3 + 3 M and 2 + 2 m; acropygidium distinct, rounded, edge crenulate; carinae distinct; forceps short and broad (as illustrated) and strongly bent upward toward

the tips; right forcep with seven sharp, recurved teeth, left forcep with five similar teeth, each forcep with ten large setae of which the outer, basal one is plumose; and nine smaller setae of which four arise near the dental margin; length of forcep 0.14 mm; length of body, including forceps 2.89 mm.

Male.—Similar to female except no spermathecae; large median internal setose sac opening ventrally on scutum III near the suture between the prescutum and scutum, tip of sac extending anteriorly to posterior margin of second urosternite, setae near the mouth of the sac plumose, the rest simple; lateral subcoxal organs with 6 + 6 plumose sense-setae and numerous hyaline glandular setae almost as long as the sense setae; right forcep with six teeth, left forcep with five teeth; length of body 2.72 mm.

Holotype female and allotype male (California Academy of Sciences) and paratype female and male (University of California, Davis) were collected in leaf mold NEAR OAKLAND, ALAMEDA COUNTY, CALIFORNIA, in January, 1953 by Mr. Robert O. Schuster.

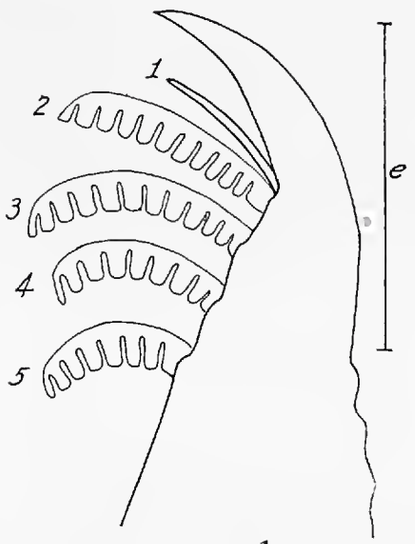
I take pleasure in naming this species after M. L. Pagés of the Laboratoire de Biologie Animale, Université de Dijon, France, in recognition of his fine work in the taxonomy of the Japygidae.

Nanojapyx pricei L. Smith, new species

Female.—Similar to *N. pagesi* L. Smith except setae at dorsal apex of femora, number 3 equal in length to number 1; setae on labial palp 4; meso-and metanotum 8 + 8 M; setae number 1 on forceps usually simple or minutely plumose; length of forceps 0.18 mm; right forcep with seven teeth, left with six teeth; tips of forceps strongly curved inward, as illustrated; lateral subcoxal organs each with six or seven plumose sense setae; ventral setae associated with stylus VII as in *pagesi* but with three pinnulae each; abdominal segment X, width 0.20 mm, length 0.28 mm; length of body, including forceps 3.83 mm.

EXPLANATION OF FIGURES

Fig. 1, lacinia of *Nanojapyx pagesi* L. Smith showing rod-like structure of the first lamina, e = 0.05 mm; fig. 2, male sac in III of *pagesi* dorsal view, e = 0.05 mm; fig. 3. spermathecae of *pagesi* dorsal view; fig. 4, eighteenth antennal segment of *pagesi* female, dorsal view, e = 0.05 mm; fig. 5, apex of femur of *pagesi* dorsal view showing plumose setae 1 and 2, and simple seta number 3; fig. 6, tarsus of L 2 of *pagesi* ventral view showing two rows of two stout setae each, e = 0.05 mm; fig. 7, fourth antennal segment of *pagesi* female, dorsal view showing dorsal sense seta at *a*; fig. 8, labial palpus of *pagesi* female, ventral view; fig. 9, pleuron of left side of *pagesi* female showing setal pattern, left = pleurite, right = pleuron; fig. 10, tergite X of *pagesi* female, dorsal view, e = 0.10 mm; fig. 11, right stylus VII and associated setae of *pagesi*, ventral view, e = 0.05 mm; fig. 12, right stylus VII and associated setae of *N. gentilei* L. Smith ventral view, e = 0.05 mm.



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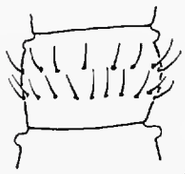

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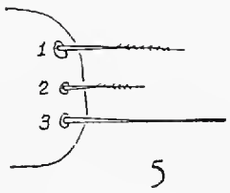

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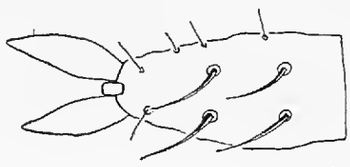

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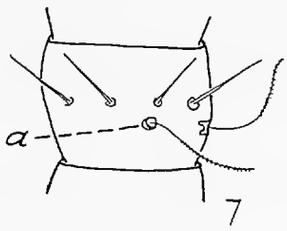

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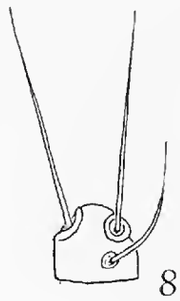

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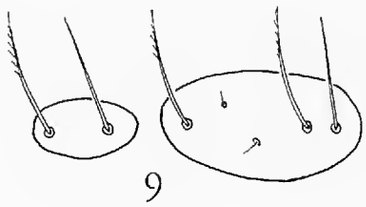

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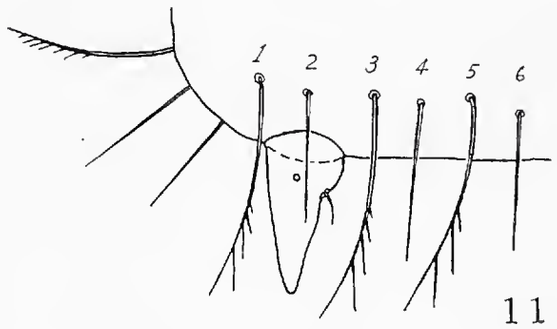

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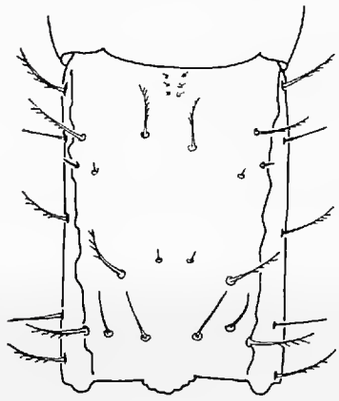

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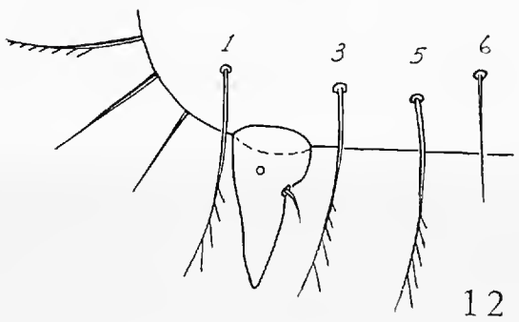

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Male.—Similar to female, except right forcep with six teeth, left with five teeth; male sac with few setae mostly simple, but nine setae show minute pinnulae near the opening of the sac; abdominal segment X, width 0.17 mm, length 0.22 mm; length of body including forceps 3.54 mm.

In addition to the six paratypes, I have examined a series of eight metatype adults from Sharp Park, San Mateo County, California. In some of these the females lack the basal tooth on the right forcep.

Holotype female and allotype male (California Academy of Sciences), and 18 paratypes (California Insect Survey; University of California, Davis; U.S. National Museum) were collected in chaparral leaf mold in the SAN BRUNO MOUNTAINS, SAN MATEO COUNTY, CALIFORNIA, in January, 1957.

I take pleasure in naming this species after Mr. Douglas W. Price who collected it.

Nanojapyx gentilei L. Smith, new species

Female.—Similar to *N. pagesi* L. Smith except setae at dorsal apex of femora, number 3 longer than number 1, number 2 shortest and not plumose; setae on labial palp 4, setae on maxillary palp 7; meso- and metanotum 7 + 8 M; seta number 1 on forceps minutely plumose; length of forceps 0.12 mm; right forcep with six teeth, left with five teeth, tips of forceps strongly curved inwards; lateral subcoxal organs each with four or five plumose sense setae; ventral setae associated with stylus VII as illustrated with setae number 2 and 4 missing; abdominal segment X, width 0.11 mm, length 0.16 mm; length of body including forceps 2.72 mm.

Male.—Unknown.

Holotype female (California Academy of Sciences), paratype female and juvenile (University of California, Davis) were collected ten to twelve inches deep in sandy soil in a growth of poison oak by L. M. Smith and R. O. Schuster near TRENTON, SONOMA COUNTY, CALIFORNIA, on August 7, 1957.

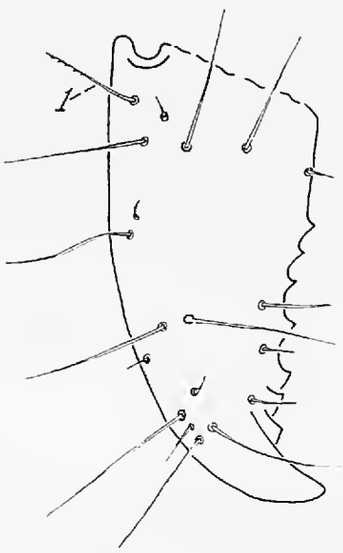
I take pleasure in naming this species for Mr. Adriano Gentile who has been of great assistance to me by translating Silvestri's works on Japygidae from Latin.

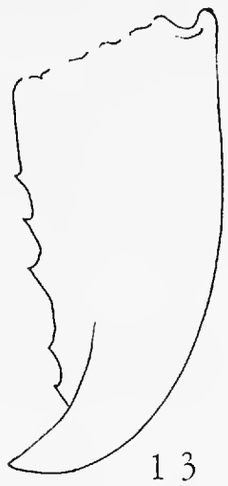
Nanojapyx hamoni L. Smith, new species

Female.—Similar to *N. pagesi* L. Smith except setae at dorsal apex of femora, numbers 1 and 2 plumose, with number 3 equal in length to number 1; setae on labial palp 4, setae on maxillary palp 7 + 8; ventral

EXPLANATION OF FIGURES

Forceps of *Nanojapyx* females, dorsal view, reversed left to right, setal pattern of all as shown in fig. 13. All figures at same magnification, e = 0.10 mm. Fig. 13, *pagesi*; fig. 14, *hamoni*, a, right, and b, left forcep; fig. 15, *pricei*; fig. 16, *gentilei*; fig. 17, *coalingae*.





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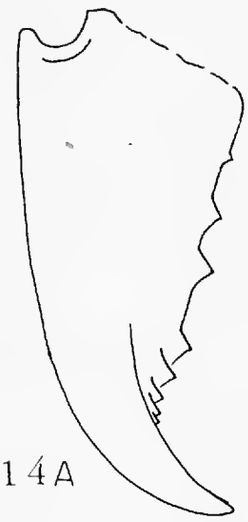

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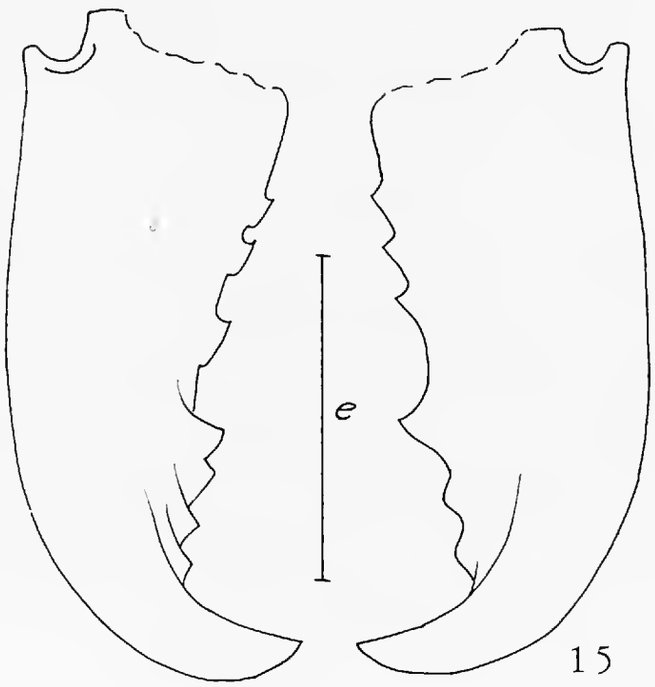

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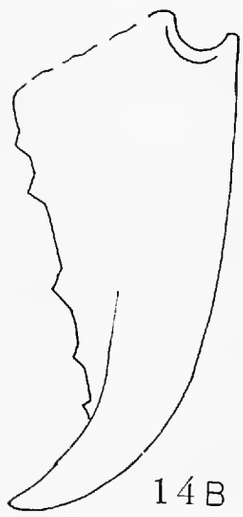

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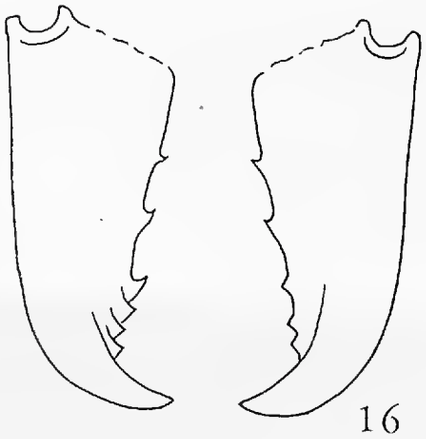

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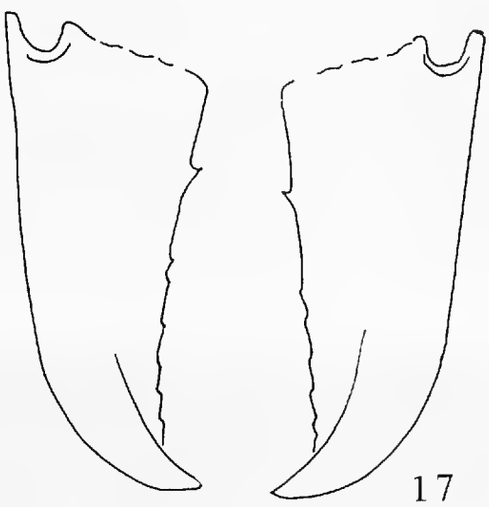

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setae per row on tarsus 3 + 3; meso- and metanotum 7 + 7 M; seta number 1 on forceps minutely plumose; length of forcep 0.14 mm; left forcep with eight teeth with distal tooth almost hidden, right forcep with five teeth, all teeth pyramidal in shape, not recurved; lateral subcoxal organ with 6 + 6 plumose sensory setae; ventral setae associated with stylus VII with setae 2 and 4 present, these become progressively smaller anteriorly, setae 1, 3, and 5 with 4 pinnulae each; segment X, width 0.19 mm, length 0.22 mm; length of body including forceps 3.40 mm.

Male.—Unknown.

Holotype female (California Academy of Sciences) collected in redwood leaf mold near HALF MOON BAY, SAN MATEO COUNTY, CALIFORNIA on July 21, 1957 by Mr. R. O. Schuster. Three female paratypes were collected in clay-loam soil and humus under Monterey Cypress, by W. H. Lange and R. Schoeppner at Wolf Ranch, San Mateo County, California, April 24, 1958 and are deposited in the collection of the U.S. National Museum, California Insect Survey and the University of California, Davis.

Nanojapyx coalingae L. Smith, new species

Female. Similar to *N. pagesi* L. Smith except antenna with 23 segments; antennal segment 18 with eight setae in the distal whorl; setae at dorsal apex of femora, numbers 1 and 2 plumose with number 1 equal in length to number 3; setae on labial palp 3, setae on maxillary palp 8; meso- and metanotum 7 + 7 M; ventral setae per row on tarsus L 1 = 2 + 2; L 2 and L 3 = 3 + 3; seta number 1 on forceps clearly plumose; tergum X setae between carinae, row A as in *pagesi*, the two pair of m posterior to A strongly developed, row B anterior of middle, C irregular, with one additional pair of m just mesad of the lateral setae, median pair of M posterior, simple, all other M plumose; length of forceps 0.14 mm, right forcep with one distinct sharp pointed recurved tooth and crenulations suggesting reminants of six teeth, left forcep the same; lateral subcoxal organ with 6 + 7 plumose sensory setae; ventral setae associated with stylus VII, seta number 2 present but small, and seta 4 absent; setae 1, 3, and 5 with four or five pinnulae; segment X width 0.14 mm, length 0.20 mm; length of body including forceps 3.06 mm.

Male.—Unknown.

Holotype female (California Academy of Sciences) was collected in juniper leaf mold NEAR COALINGA, FRESNO COUNTY, CALIFORNIA on January 22, 1958, by Mr. H. L. Wilson.

KEY TO THE SPECIES OF NANOJAPYX L. SMITH

1. Antennae with 23 segments ..... *coalingae*
– Antennae with 22 segments 2
2. Three setae per row on tarsus ..... *hamoni*
– Two setae per row on tarsus (fig. 6) 3
3. Three setae on labial palpus (fig. 8) ..... *pagesi*
– Four setae on labial palpus 4

4. Plumose seta at apex of femur shorter than adjacent simple seta (fig. 5) ..... *gentilei*
– Plumose seta at apex of femur same length as adjacent simple seta ..... *pricei*

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1957. Diplura. Genera Insectorum. Fascicule 212, p. 83.

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1949. Contributo alla conoscenza degli Japygidae (Insecta Diplura) Rend. Accad. XL, s. 3, 27:3–115.

RELEASES OF RECENTLY IMPORTED INSECT PARASITES AND PREDATORS IN CALIFORNIA, 1956–57

C. P. Clausen
University of California, Riverside

The following list, reporting the first field releases of certain imported species of parasites and predators by the Department of Biological Control, supplements two preceding reports,[1,2] covering the years 1952–53 and 1954–55. The year of first release is 1957 unless otherwise indicated.

The species listed in the 1952–53 report as *Platynaspis* (?) sp. has since been identified as *Exochomus metallicus* Korschefsky.

Host and Parasites or Predators	*Origin*	*Area or County of Release*
Saissetia oleae (Bern.)		
Coccophagus mexicensis Gir.*	Mexico	So. Calif., Tulare
Mesopeltis atrocyanea Masi	Mexico	San Diego
Metaphycus lichtensiae (How.)	Pakistan	Coastal So. Calif.
Microterys consobrinus Comp.*	Mexico	San Diego
Microterys flavus (How.) (Black scale race)	India	So. Calif.
Aonidiella aurantii (Mask.)		
Aphytis sp. (Burma)	Burma	So. Calif.
Aphytis sp. (India)	India	So. Calif.
Aphytis sp. (Pakistan)	Pakistan	So. Calif.
Chilocorus tristis Fald.[3]	Japan	San Diego San Bernardino
Cybocephalus sp.	India	So. Calif.
Pharoscymnus sp.	India	San Diego

Host and Parasites or Predators	*Origin*	*Area or County of Release*
Physcus sp.	Burma	San Diego Riverside
Telsimia sp.	Burma	So. Calif.
LEPIDOSAPHES BECKII Newm.		
Chilocorus discoideus Crotch*	Kenya	So. Calif.
PARLATORIA OLEAE (Colvée)		
Aphytis sp.	Pakistan	San Joaquin Valley
Archenomus sp.	Pakistan	San Joaquin Valley
Coccophagoides sp.	Pakistan	Fresno Tulare
PLANOCOCCUS CITRI (Risso)		
Nephus sp.	Mexico	Ventura
THERIOAPHIS MACULATA (Buckton)		
Adonia variegata Gze.[4]	India	Riverside Fresno Yolo
Chrysopa carnea Steph.[4]	India	So. Calif. Yolo
Scymus nubilis Muls.[4]	India	Riverside Yolo
Synharmonia conglobata (L.)*	Turkey	San Diego
APHIS SPIRAECOLA Patch		
Aphelinus chaonia Wlkr.*	Hong Kong	Riverside
TETRANYCHIDAE AND ERIOPHYIDAE (various)		
Stethorus sp. "P"	Pakistan	San Diego
Stethorus sp. "D"	India	San Diego Riverside Santa Barbara
PHYTOPHAGOUS SNAILS		
Gonaxis kibweziensis (Smith)*[5]	Agiguan	San Diego

* First releases made in 1956.

1 Pan-Pacific Entom. 31(2) :90-2. 1955.

2 Pan-Pacific Entom. 32(3) :125-7. 1956.

3 Received from Canadian Department of Agriculture.

4 Received from Entomology Research Division, U.S.D.A.

5 Received from Pacific Science Board and Hawaii Board of Agriculture and Forestry.

NOTES ON THE CALIFORNIA SPECIES OF THE GENUS PYLA GROTE

(Lepidoptera: Pyralidoidea)

JERRY A. POWELL

University of California, Berkeley

The black moths of the genus *Pyla* Grote are dayflying phycitids which, in western North America, inhabit boreal regions. Carl Heinrich, in his magnificent monograph of the Phycitinae (1956), divided the genus into two superficial species groups, those with grey forewings and those with shining black-brown wings. Four species are recorded from California, all of which are members of the latter group, the typical *Pyla* of the earlier authors.

During the course of the past few seasons, collecting in the mountains of northern California[1] has produced certain distributional data which seem significant. It has become apparent that *P. sylphiella* Dyar, previously only reported from Washington and British Columbia extends southward and is continuous with the California species, *P. scintillans* (Grote). In addition, a few remarks on variation and a description of the female of *P. nigricula* Heinrich are included in the present paper. Where not otherwise indicated in the data, the collection records are my own.

PYLA SCINTILLANS (Grote)[2]

Nephopteryx scintillans Grote, Papilio, Vol. 1, p. 18, 1881.

Pyla scintillans (Grote), Heinrich, U.S. Nat. Mus., Bull. 207, p. 146, 1956.

Pyla sylphiella Dyar, *Ins. Insc. Menstr.*, Vol. 9, p. 68, 1921; Heinrich, U.S. Nat. Mus., Bull. 207, p. 147, 1956. (New synonymy.)

A shining, dark brown species with usually only faint indications of darker transverse banding on the forewing. Very distinctly marked specimens show dark markings on the forewings as follows: a broad median band which angles slightly outward; a thin subapical, usually somewhat sinuate, band; sometimes an irregular blotch between the bands on the dorsal margin. It may be easily distinguished from *P. fasciella* Barnes and McDunnough and *P. nigricula* Heinrich, which it closely resembles, by its longer palpi (exceed the head by about twice the diameter of the eye as seen from side, fig. 1). Alar expanse 20–26 mm.

---

1 Field investigations during August, 1957 and July, 1958 carried out with the California Insect Survey, University of California, Berkeley.

2 Complete synonymy has been given by Heinrich (1956).

Heinrich lists the distribution as Sierran, from Mineralking, Tulare County northward to Cisco, Placer County, all at high elevations. It is apparent, however, from the specimens I have examined, that in California the species ranges throughout the Sierras, the north central part of the state, and thence southward along the inner North Coast Ranges for some distance. The species is, in general, an early flier compared to the other California *Pyla,* with almost all collections having been made in July.

Heinrich, in his treatment of the genus, recognized both *P. scintillans* (Grote) and *P. sylphiella* Dyar as valid species even though they are indistinguishable on the basis of external characters. His criteria for separation were: minor differences in the male genitalia, the markedly different female genitalia, and the allopatric distribution of the two species. However, the California specimens of the complex are extremely variable in genitalic characters and include intermediates between his interpretation of *P. scintillans* and *P. sylphiella.* A series from Del Norte County seems to be fairly uniform in representing a southern extension of *P. sylphiella* in both male and female characters. A male from southern Siskiyou County appears to be intermediate in the harpe enlargements, while the aedeagus is of the *P. sylphiella* type. A male from Shasta County, although having the harpe characters of *P. sylphiella,* has one element of the aedeagus with one short thorn, the other with three, a situation typical of *P. scintillans.* The female genitalia in the specimens examined exhibit more variability than was indicated by Heinrich. Typical *P. sylphiella* forms occur in Del Norte and Siskiyou Counties, but not consistently. One interesting variety lacks both the heavily sclerotized deep folds of the lower part of the cup-shaped portion of the ductus bursae characteristic of *P. sylphiella* and the oval, blade-like projections of the cup evident in *P. scintillans.* This variant (fig. 3) has been found in random individuals from Del Norte County and in single specimens from Plumas and Glenn Counties. This may represent an intermediate form. Specimens from the southern Sierras seem more typical of *P. scintillans* in both sexes, but I have not seen any females really typical of either of the *P. scintillans* varieties figured by Heinrich.

In view of the nature of the intergrading characteristics evident in the complex, I regard *Pyla sylphiella* Dyar as a synonym

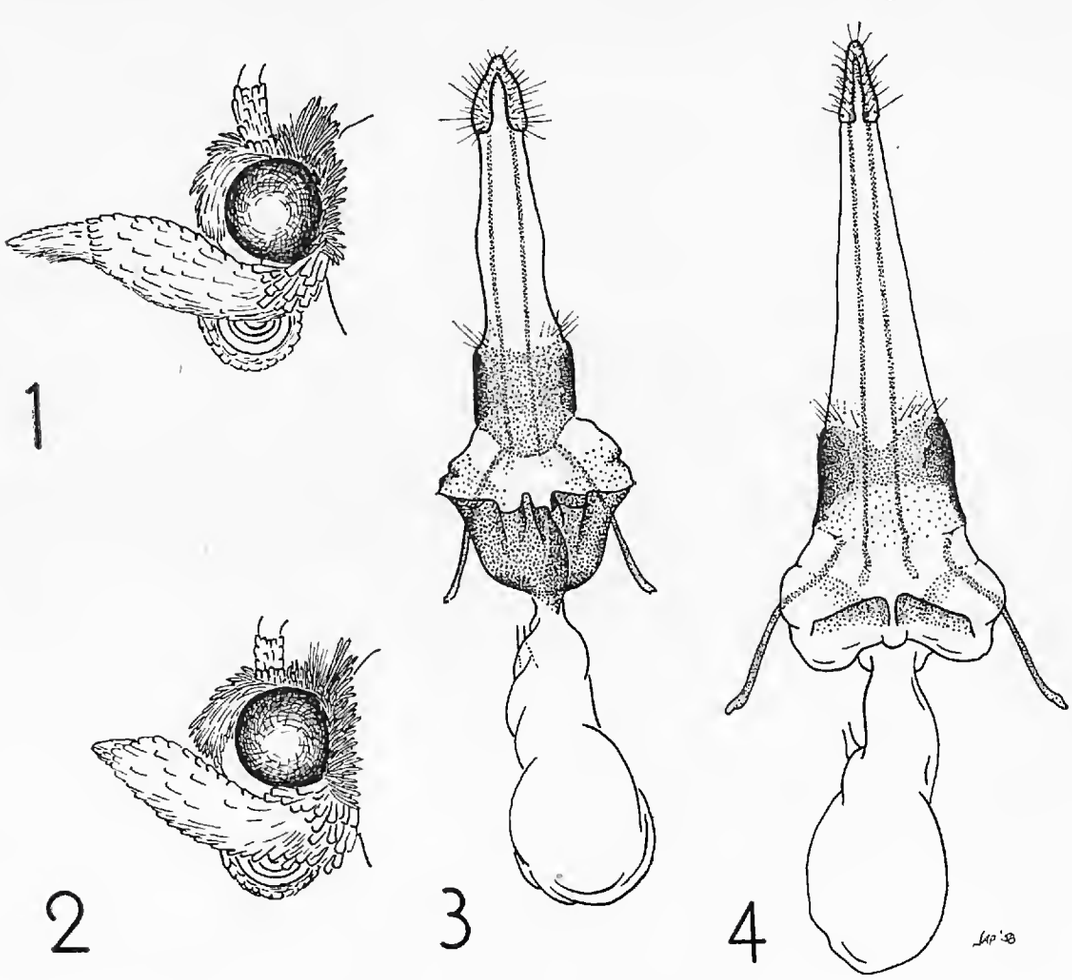
of *P. scintillans* (Grote), *P. scintillans* being a widespread species (central California north to British Columbia).

Material examined: (See map) 1♂, 5 mi. W. Sonora Pass, Tuolumne Co. VII.21.56; 1♀, Sonora Pass, Tuolumne Co. VII.21.56; 1♀, Glen Alpine Cr., El Dorado Co. VII.18.09 (F. X. Williams); 1♀, Mohawk, Plumas Co. VII.8.38 (W. R. Bauer); 1♀, Chester, 6 mi. E., Plumas Co. VII.14.54; 1♂, Hat Creek P. O., Shasta Co. VII.11.56 (J. W. MacSwain); 1♂, "Caslella" [prob. Castella, Shasta Co.] VII.'02 (no collector); 1♂, 1♀, Mt. Shasta City, Siskiyou Co. VII.2.58; 3♂♂, 11♀♀, Little Grayback. N.E. Del Norte Co. VII.9.58; 1♀, 5 mi. N. Black Butte, Glenn Co. 6200', VI.19.56.

Pyla nigricula Heinrich

Pyla nigricula Heinrich, U.S. Nat. Mus., Bull. 207, p. 148, 1956.

Superficially *P. nigricula* is very much like *P. scintillans*, from which it differs by the smaller palpi (exceed the head by only about the diameter of the eye as seen from side, fig. 2), and



Explanation of Figures

Fig. 1, Lateral view of head of *Pyla scintillans* (Grote); fig. 2, Lateral view of head of *Pyla nigricula* Heinrich; fig. 3, Female genitalia (variant) of *Pyla scintillans* (Grote); fig. 4, Female genitalia of *Pyla nigricula* Heinrich.

apparently is almost indistinguishable from *P. fasciella*. All three are easily separated by their genital characters. Heinrich described *P. nigricula* from a unique male collected by A. H. Vachell at Verdi, Nevada. I have encountered it at spots to the south of the Lake Tahoe region, but only at elevations above 10,000 feet. Verdi is on the eastern side of the Sierras, and it seems probable that the specimen was collected in the mountains near Verdi to the west.

The male exhibits some variation in wing color, and I have a specimen which differs from the original description as follows: both the antemedial and submarginal dark bands of the forewing clearly indicated, the area between, as well as the margin, with the same bluish overscaling as is present on basal area. Another has just a faint suggestion of the median bluish, otherwise closely resembling the type description. Alar expanse 23–25 mm. (the type is 26 mm.).

The unique type is a male, and the previously unknown female is described at this time.

Head, palpi, other appendages, as in male. *Forewing* black, tinged with bluish overscaling as follows: basal area, median area except for an indistinct center blotch, a thin, distinct submarginal transverse line parallel with margin, marginal area; remaining black bands as follows: antemedial oblique line, irregular blotch at end of cell, two submarginal thin bands on either side of the distinct blue line. (In older specimens the bluish tends to become obscure, giving a less distinctly marked appearance). *Hind wing*, shiny dark brown as in male. Alar expanse 23–24 mm. *Genitalia* as in fig. 4 (three specimens examined), close to *P. fasciella* Barnes and McDunnough but differing by the smaller ovipositor pads (ratio of ovipositor pad length to: posterior apophyses distad of pads to: length of sclerotized band of ninth segment about 1:6:1.5; in *P. fasciella* about 1:4:1) and by minor differences in shape of the sclerotization of the ninth segment and paired plates of ductus bursae.

Neallotype female: SONORA PEAK, TUOLUMNE COUNTY, CALIFORNIA, August 10, 1957 (J. Powell) deposited in the California Insect Survey collection, University of California, Berkeley.

I have not seen *P. fasciella*, but judging from the description given by Heinrich, it is nearly indistinguishable from *P. nigricula* in external characters. Although the genitalia are distinct, the two entities are also geographically isolated (*P. fasciella* is known only from Mt. Shasta in northern California), and perhaps the status of *P. nigricula* should be reëvaluated when more material becomes available, especially from the intervening areas. It seems

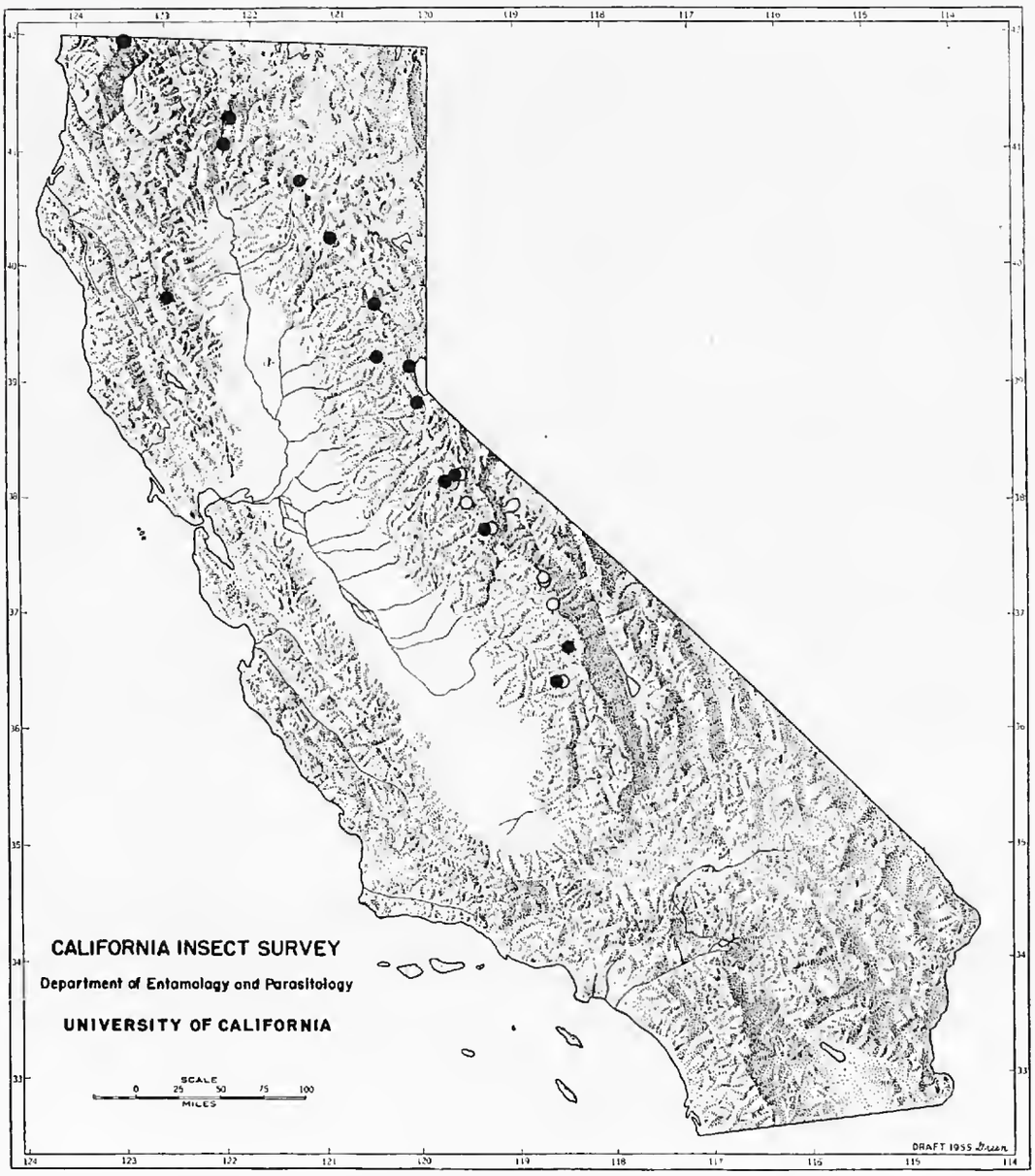
a distinct possibility that *P. nigricula* Heinrich represents a genitalic variant.

Material examined: 1 ♀, Ruby Lake, Inyo County [11,250 ft.] VIII.13.57; 1 ♀, near Mono Pass, Inyo County, 12,000′, VIII.11.57 (C. D. MacNeill); 1 ♂, Sonora Pass, Tuolumne County, VII.21.56; 2 ♂ ♂, near Sonora Peak, Tuolumne County, 11,000′, VII.14.57 (C. D. MacNeill); 4 ♀ ♀, Sonora Peak, Tuolumne County, VIII.10.57.

Pyla viridisuffusella Barnes and McDunnough

Pyla viridisuffusella Barnes and McDunnough, Can. Ent., Vol. 49, p. 406, 1917; Heinrich, U.S. Nat. Mus., Bull. 207, p. 149, 1956.

A smaller moth (expanse 17–20 mm.), quite distinct from the



Explanation of Map

Distribution of *Pyla scintillans* (Grote) (closed circles) and *Pyla viridisuffusella* Barnes and McDunnough (open circles) in California according to material examined and localities given by Heinrich (1956).

above mentioned species, with a shining metallic green or bronzy overscaling and usually with rather distinct transverse bands on the forewing. The intensity and quality of the color varies considerably between individuals.

Heinrich gives its distribution as the southern high Sierras, ranging from Mineralking, Tulare County, north to Kennick Meadows, Tuolumne County. The present records extend a little more northward. It was flying quite abundantly in northwest Inyo County in mid-August, along with occasional examples of *P. nigricula* Heinrich and another abundant Phycitine, *Catasia bistriatella* (Hulst), which it resembles on the wing.

Material examined: (See map) 1♂, 2♀♀, Ruby Lake, N.W. Inyo Co. VIII.13.57 (C. D. MacNeill), 7♂♂, 3♀♀, same data (J. Powell); 3♂♂, 2♀♀, nr. Mono Pass, Inyo Co. 12,000′, VIII.(10–15).57 (C. D. MacNeill); 3♂♂, 4♀♀, same data (J. Powell); 1♂, Tuolumne Meadows, Tuolumne Co. "VIII.(1–7)" (no collector); 3♂♂, 1♀, Kennick Meadows, Yosemite Nat'l. Park, alt. 9,250′, VII.28.34 (E. O. Essig); 1♀, nr. Sonora Peak, Tuolumne Co. 11,000′, VII.10.57 (C. D. MacNeill), 2♀♀, same data (J. Powell).

I would like to acknowledge with thanks the help of C. Don MacNeill of the Department of Entomology, California Academy of Sciences, San Francisco, for the loan of specimens and for assistance in the field, and Dr. P. D. Hurd, Jr., of the Department of Entomology, University of California, Berkeley, for reading the manuscript and suggestions.

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1956. American moths of the Subfamily Phycitinae. U.S. Nat. Mus., Bull. 207, 581 pp.

OBSERVATIONS ON THE SURVIVAL OF ARHOPALUS PRODUCTUS (LeCONTE) LARVAE IN DOUGLAS-FIR LUMBER

(Coleoptera: Cerambycidae)

Charles B. Eaton

California Forest and Range Experiment Station[1]

Forest Service, U.S. Department of Agriculture

Larvae of the roundheaded borer, *Arhopalus productus* (LeConte), often are found in the wood of dying or dead

1 Maintained at Berkeley, California, in cooperation with the University of California.

Douglas-fir trees. They are known to be able to survive and to continue to develop in recently cut lumber from such trees, even after it has been used in buildings. Because the adults and larvae of this beetle occasionally bore holes through floors, ceilings, walls, and roofs of new structures, they sometimes are a problem to lumber suppliers, builders, and home owners (Eaton and Lyon, 1955).

Emergence in buildings has almost invariably been reported as occurring within a year after the buildings were constructed. One might infer that the beetles all complete their development in a single year. This is contrary to what we know or suspect about the insect's life span in nature. Kimmey and Furniss (1943) report that the beetles, normally, probably take several years to reach maturity. A more plausible explanation for the absence of the beetles in buildings after the first year is that the environment becomes unfavorable for those that are unable to mature in this period. Consequently they die.

In their natural environment *A. productus* beetles develop in fairly moist wood. In buildings constructed with infested lumber that is green when first used, the drying that takes place would result in conditions quite different from those of wood still in the tree in the forest. These conditions probably would tend to deter larval development, and it is conceivable that only the more fully developed individuals would reach the adult stage. Some support for this belief was found from observations on the survival of a few larvae in lumber kept indoors at Berkeley, California, over a 13-month period.

In November 1955, two pieces of infested Douglas-fir, about 2 inches by 4 inches by 4 feet in size, were obtained from recently cut fire-killed trees near Jenner, Sonoma County, California. When brought indoors, the wood was very moist, prominently bluestained, and well riddled with roundheaded-borer galleries. The larvae were located by cutting along their galleries through the wood. After their size and condition were noted, the larvae were sealed in their galleries with black masking tape. The tape was removed briefly at intervals of one to two months so that the condition of the larvae could be observed.

Eight larvae were found in the two pieces of lumber. One additional larva escaped detection, but was discovered when the wood was split up in September 1957. The larvae were kept under

observation from November 16, 1955 to December 27, 1956. At the beginning of this period they were thought to be between one-half and three-fourths grown. However, head-capsule measurements of those that died revealed that all but one were of the same size, presumably full grown.

Only one of the eight larvae completed its development. The remainder died at various lengths of time after observations were begun. The one individual that survived was a male that emerged as a full-grown beetle at seven months. Of those that died, one succumbed after one month, one after four months, three after seven months, one after ten months, and one after thirteen months.

The moisture content of green Douglas-fir sapwood is normally 100 per cent or more of its oven-dry weight. However, under indoor conditions, such as those in which the samples were held, moisture content would gradually decrease to the level commonly reached in buildings in this area, i.e., about 10 per cent. During the early part of the observation period, when the samples were still fairly moist, most of the larvae continued their mines. However, as the wood dried, they became less and less active. The frass they produced, which is normally fairly coarse, became very fine. The larvae, instead of increasing in size, became smaller so that in death their corpses were mummified. These observations suggest that the wood became too dry for the larvae to survive, and that they died from dessication. When infested lumber is used in buildings, many larvae probably suffer the same fate. This may explain why *A. productus* damage is seldom reported beyond the first year after construction.

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Kimmey, J. W. and Furniss, R. L.

1943. Deterioration of fire-killed Douglas-fir. U.S. Dept. Agr. Tech. Bul. 851, 61 pp., illus.

A PREOCCUPIED NAME IN SOLIERELLA

(Hymenoptera: Sphecidae)

Solierella prosopidis Williams, new name, is proposed for *Solierella mandibularis* Williams. *Solierella mandibularis* Williams (Pan-Pac. Ent., 34:212, 1958) is preoccupied by *Solierella mandibularis* de Beaumont (Bull. Soc. Sci. Nat. Phys. du Maroc, 36:147, 1957).—Francis X. Williams, *La Mesa, California.*

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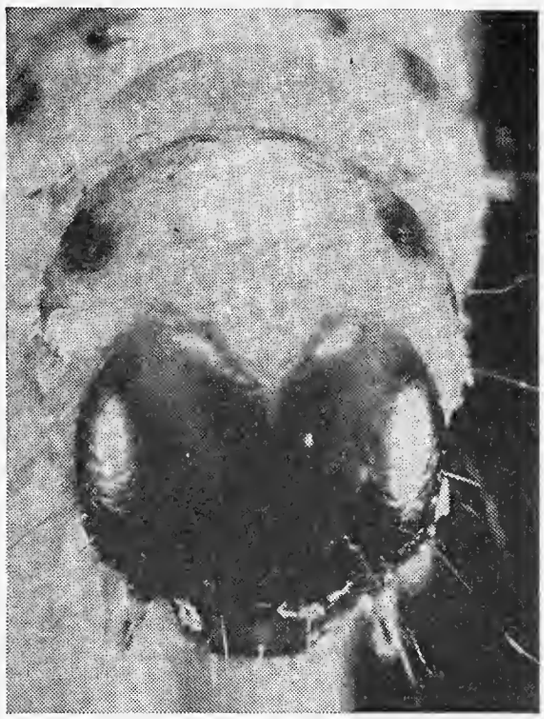

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PRESENT STATUS OF THE TRIBE MAYETINI IN THE UNITED STATES

Part I (Excluding California)

(Coleoptera: Pselaphidae)

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INTRODUCTION

The tribe Mayetini was transferred by Park (1947) from the family Staphylinidae to the family Pselaphidae. The genus *Mayetia* was included in keys to the North American Pselaphidae in 1951 and 1953 based on undescribed material (Park 1951, 1953). In 1955, Jeannel and Coiffait published a paper placing the tribe Mayetini in the subfamily Faroninae of the Pselaphidae and Coiffait (1955) revised the European species of *Mayetia*. The revision and one subsequent paper by Coiffait considered a total of 38 species of *Mayetia* occurring in countries bordering the Mediterranean Sea.

Prior to any of the above mentioned papers, Dr. Robert Bowman defined a species, "*Mayetia chapini*", in the appendix of a manuscript entitled "Classification of Coleoptera". About 20 manuscript copies of this work were given on request to coleopterists. Although the work was never published, the "type series" was deposited in the USNM. The unpublished work of Bowman was not sufficient to consider "*M. chapini*" as a valid species and his material, with his consent, is reconsidered in this paper.

Specimens of *Mayetia* collected in the United States date back to 1935. Until 1957, less than 100 specimens were available for study. Although *Mayetia* are not common in collections, they occur in moderate numbers at some localities and may be equally abundant in other areas where they are to be found. On the basis of the few collections thus far examined, it seems reasonable to predict that in due time the species of North American *Mayetia* as well as the number of specimens available for study should be augmented greatly.

Adults are represented for all the seasons by composite

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collections from various sections of the United States. Nothing is known of the larval forms or of the habits of the adults.

Specimens of *Mayetia* have been recovered from such diverse habitats as prairie soil, pine or oak situations, sphagnum moss, and peach orchards. An attempt to correlate the distribution of *Mayetia* with vegetation or soil types would be premature at this time although most of the collection records point to their preference for sandy soils. A possible historical factor influencing the distribution of *Mayetia* in the eastern United States may have been the Wisconsin Glaciation. Further collection is needed to substantiate the proposition that *Mayetia* occur only south of perifery of that ice sheet.

Collection and Preparation

A suitable method of collection and preservation is given below in hopes that our experience may prove helpful and increase interest in collecting these soil-inhabiting insects.

Mineral soil immediately below any organic debris was collected in the field, placed in multi-layered paper sacks and later processed into 95% ethanol by modified Berlese funnel in the laboratory. Due to the small particle size of the soil, the combination of a mesh of window screen and a grid (Newell, 1955) proved insufficient to maintain debris-free samples. The addition of a single layer of cheese cloth placed on the screen eliminated most of the sand without impeding the recovery of *Mayetia*. A volume of soil 4 inches deep and 16 inches square was processed from 8 to 12 hours using a 100 watt light bulb as the heat source. Specimens of *Mayetia* were recovered from the sample bottles by pouring the contents into petri dishes and examining under a dissecting microscope.

The specimens clear easily in a warm solution of 1 part super-saturated Merk phenol and 3 parts 85% lactic acid. The majority of our specimens have been mounted in Hoyer's medium after removal of the lactophenol by placing the beetles for a time in water. Specimens may be dehydrated and mounted in diaphane or Canada balsam but caution must be exercised or distortion of the extremities may result.

Stender dishes provide adequate containers for the solutions in which specimens are processed. An insect pin with the end flattened at a 60 degree angle to the shaft makes an excellent scoop for handling these small beetles.

One method for removing the genital structure is preferred. The cleared specimen is placed on a slide in a drop of Hoyer's. Either substaged lighting or a white-surfaced stage with adequate top lighting and a magnification of about 60X is required. Two sharp minuten pins in handles are used to open the ultimate segment and remove the genital structure. This is then transferred to a drop of Hoyer's on a clean slide, the genital segments removed and 15 mm. round cover slip applied. Slight pressure at this time will position the aedeagus as desired. The remainder of the insect is mounted on the same slide obviating any chance of losing either part.

Taxonomy

European species of *Mayetia* in the Bernhauer Collection at the Chicago Natural History Museum were compared with our American species and found to be congeneric. The type of the genus, *Mayetia sphaerifera* Mulsant and Ray is in closest agreement with species occurring in the eastern part of the United States, and all of our species fall within the range of variability occurring in European species.

Some of the characters that help to separate the American species are variable within certain populations and must therefore be used with caution. Others, usually degrees of development of a structure, will adequately separate species.

The presence and degree of foveation, while extensively used in the discrimination of pselaphid genera, varies in *Mayetia*. Foveae are more pronounced in eastern populations, but elytral foveae are frequently developed only on one elytron of a given individual and are occasionally completely absent.

The most reliable characters of the head appear to be the maxillary palpi and the mentum. When gross sense organs are present on the maxillary palpi, segment 3 bears a large lateral development and segment 4 bears a similar development on the basal-lateral margin. Two, or occasionally three, sensory setae of various configuration occur on the anterior-lateral margin of the fourth segment as well as a terminal palpal cone (fifth segment of some European authors). The sensory areas of the palpi are reduced in one eastern species and are absent in those from California which are to be considered in a later paper.

In all species 2 setae arise from the mentum. In only a few

species large integumental projections arise anterior to those setae. One or two large circular markings occur on the head capsule just behind the mentum, depending on the species. One or two setae occur laterad of these markings, posterior to the basal-lateral angle of the mentum. These setae vary within species population. The left mandibular ramus of all eastern species bears a triangular tooth, the right an "M"-shaped tooth. Some emphasis is placed on the front margin of the labrum in separating European species, and this structure is of slightly different shape in American species. It is sexually dimorphic but other characters more easily separate the sexes. Due to an apparent change in shape of the labrum when the angle of observation is changed, and to an actual diversity of form displayed by specimens of a given species, this labral character is not exploited in this paper.

Besides the characters of the head, the meso- or more usually the metatrochanters are quite distinctive. These trochanter modifications may be present in both sexes, restricted to the males, or lacking in both sexes.

The length and width of the sixth tergite and sternite of the female is of some taxonomic value but many species will share the same measurements. The ultimate sternite of the male is medianly emarginate but the shape of this notch is of limited value because of the similarity between most species.

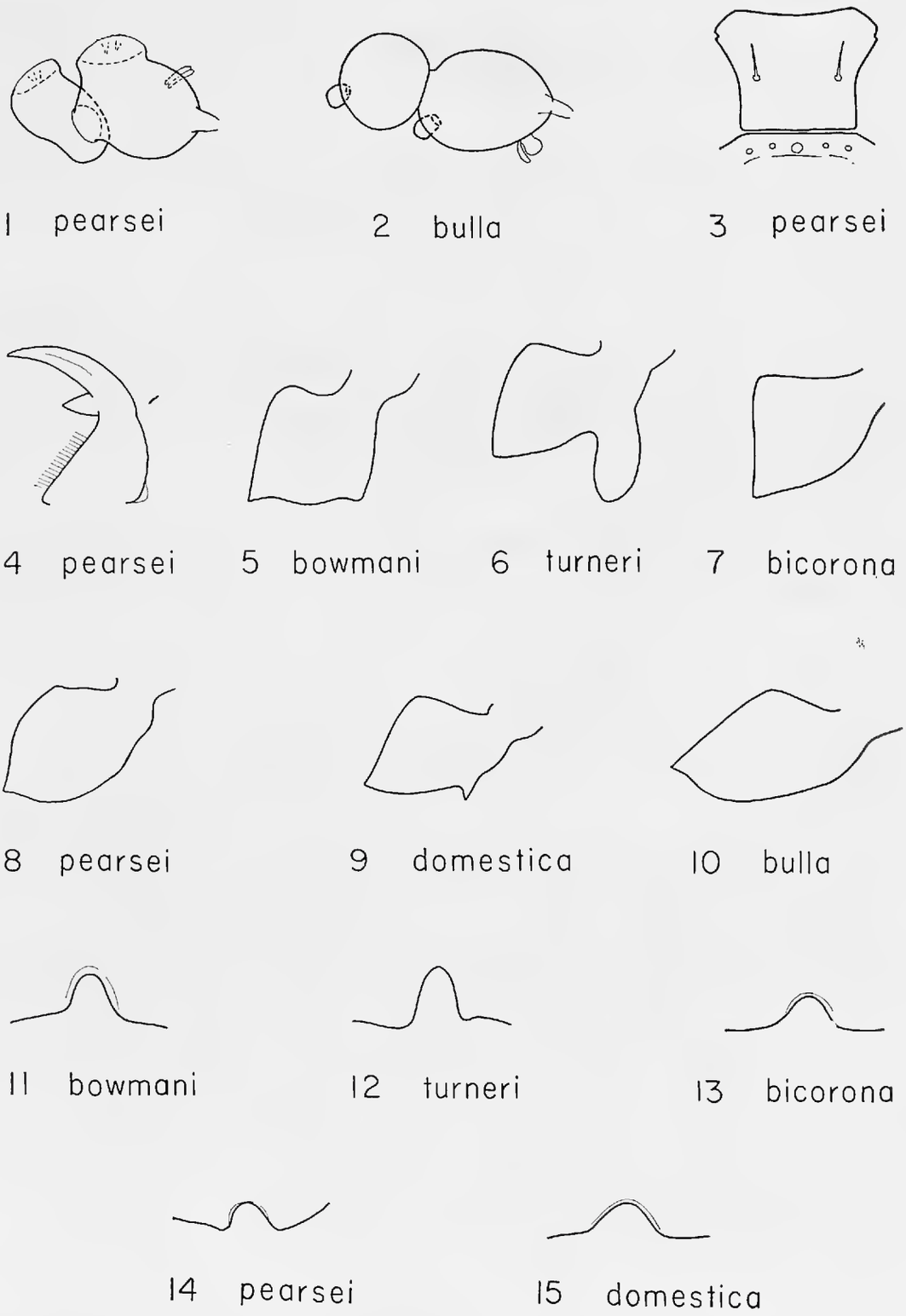
As more species are described, the male aedeagus probably will become the main structure for species determination. In resulting species groups the females may be inseparable.

Mayetia bowmani Schuster, Marsh, and Park, new species

(Figs. 5, 11, 16)

Male.—Head 0.11 mm. long × 0.12 mm. wide; pronotum 0.12 mm × 0.11 mm.; elytra 0.11 mm. × 0.12 mm. total length 0.97 mm. Elongate depressed; pale testaceous; impunctate; body pubescence monaxial, straight, suberect. Head lacking eyes; tempora sharply rounded at neck; 2 small vertexal foveae at middle, separated by the distance between fovea and lateral margin; feeble sulci extend forward from each vertexal fovea; frontal margin sinuate between antennal acetabulae; clypeus short, transverse; labrum tridentate on each side of excavate middle; mandibles arcuate; inner ramus of right mandible with symmetrical "M"-shaped tooth; tooth of left ramus triangular; ventral surface of head with small centrally located gular fovea; mentum with a pair of setae; a circular mark occurs on the head capsule with a pair of setae behind each basal-lateral angle of the mentum. Maxillary palpus with large annular sensory areas

on segments III and IV; segment IV with 3 small sensory setae on lateral surface. Antenna of 11 segments; I twice as long as II, narrowed basally; III, IV, VI, and VIII narrower than V and VII; IX through XI forming



Explanation of Plate 1

Figs. 1,2. Segments III and IV of maxillary palpi; fig.3. Mentum and front margin of head capsule; fig. 4. Left mandible; figs. 5–10. Male metatrochanters; figs. 11–15. Emarginations of male sixth sternites.

club with X and XI connate; X cup shaped with 4 macrosetae; XI with 7 long, lamellate setae spaced equidistally around base. Pronotum longer than wide, widest near apical third. Apterous. Elytron lacks basal and subhumeral fovea; definite fovea present at beginning of sutural stria; humeral angles rounded; lateral margins weakly expanded. Abdomen of 6 visible tergites: I through V similar in shape; V and VI not separated by areolate membrane; II through V with fovea at each basal-lateral angle, foveae transversely connected by pubescent sulci; VI rounded distally with marginal spiracles at the anterior fourth; six visible sternites; I with wide coxal lines; II through V alike and similar to the tergites; VI with a median emargination; the apices of a paired segment are external, sclerotized and terminal. Prosternum long, integument smooth before coxae, reticulate laterally; mesosternum reticulate; meso- and metacoxae contiguous; each tibia with 1 macroseta midway on anterior surface and definite combs of setae occur at the apex; mesotrochanters with a slight inner-posterior angle; metatrochanters relatively square (Fig. 5), the posterior edge being developed with 1 or 2 tubercles at the angle, the inner tubercle bearing a seta; tarsi of 2 segments ending in a single strong claw. Sixth sternite is approximately 0.059 mm. long, the rather widely sinuate notch (Fig. 11) being just less than 1/3 this length. Aedeagus 0.092 mm. long × 0.047 mm. wide (Fig. 16).

Female.—As in the male except for the termination of the sixth sternite which lacks emargination.

This species is known from 8 males and 9 females from ANDROPOGON BALD, SHUT-IN-RIDGE, BENT CREEK EXP. FOREST, BUNCOMBE COUNTY, NORTH CAROLINA by A. P. Jacot #34f34. The holotype (USNM 64116) is deposited in the USNM, paratypes in the USNM, and in the collections of Orlando Park and R. O. Schuster.

This species may be recognized by the metatrochanters which are modified in both sexes.

Mayetia turneri Schuster, Marsh, and Park, new species

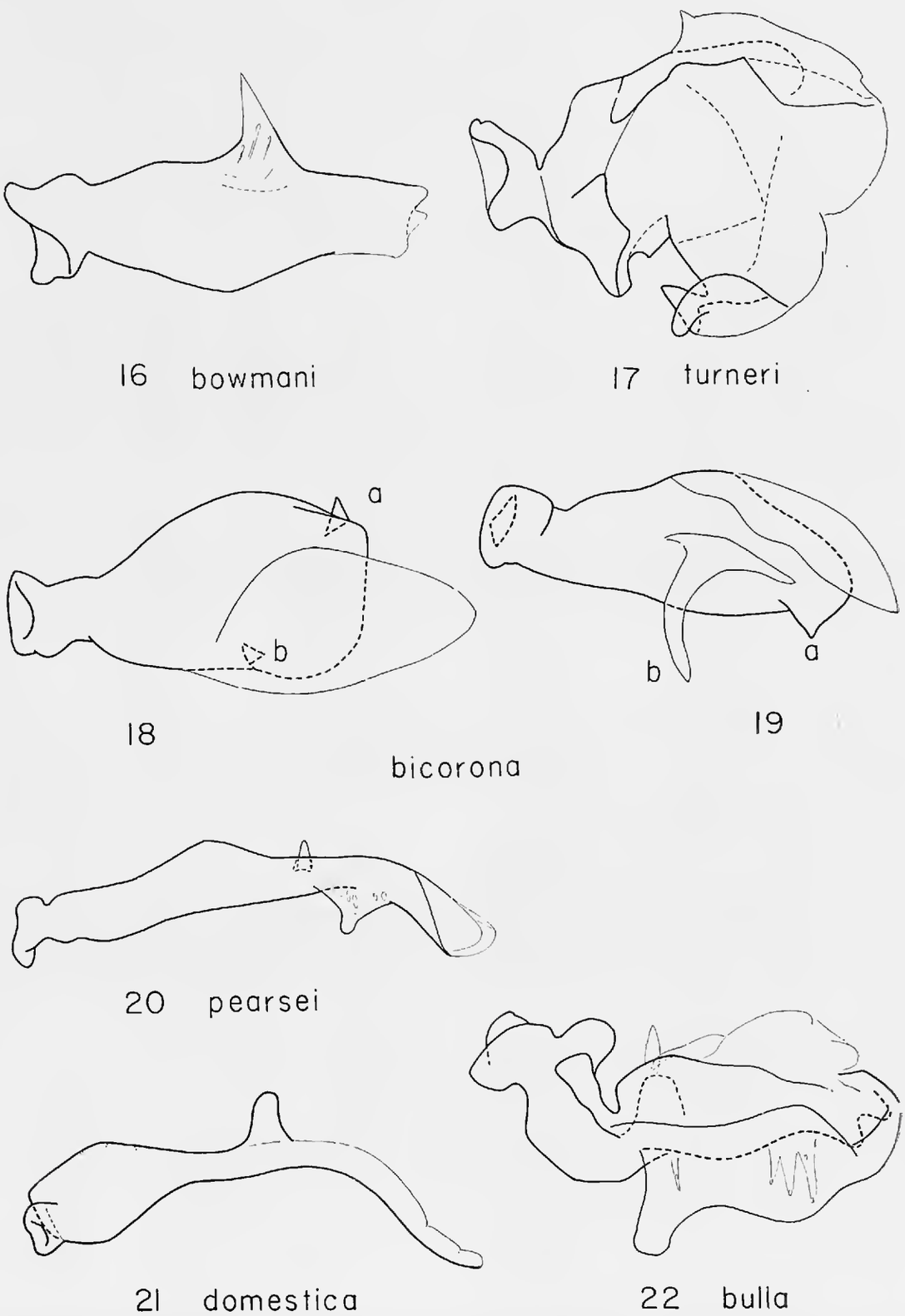
(Figs. 6, 12, 17)

Male.—Head 0.11 mm. long × 0.11 mm. pronotum 0.13 mm. × 0.11 mm.; elytra 0.10 mm. × 0.12 mm.; total length 0.81 mm. In general as described for *M. bowmani*: Maxillary palpi bearing large sensory areas on third and fourth segments; tooth of left mandibular ramus triangular; mentum simple except for the 2 setae; front margin of head capsule with 1 median mark and 1 seta on each side; metatrochanter (Fig. 6) with broad inner-posterior spine. Sixth sternite is approximately 0.084 mm. long, the notch 0.027 mm. (Fig. 12). Aedeagus 0.114 mm. long × 0.089 mm. wide (Fig. 17).

Female.—Unknown.

Holotype male was collected at MOORE COUNTY, NORTH CAR-

OLINA, May 8, 1937 by W. F. Turner from a peach orchard. Other information accompanying the specimen was "Ident.



EXPLANATION OF PLATE 2

Figs. 16–22. Aedeagi, in figs. 18, 19, the same structure is rotated 45 degrees.

37-21727" and the number "T4300." The type (USNM 64117) is deposited in the USNM.

The large sensory areas of the palpi, lack of integumental projections on the mentum and the single seta posterior to the basal-lateral angle of the mentum distinguish this species.

Mayetia bicorona Schuster, Marsh, and Park, new species
(Figs. 7, 13, 18, 19)

Male.—Head 0.12 mm. long × 0.11 mm. wide; pronotum 0.12 mm. × 0.09 mm.; elytra 0.10 mm. × 0.10 mm.; total length 0.87 mm. Essentially as described for *M. bowmani:* Maxillary palpus with large sensory areas; left mandibular ramus with triangular tooth; mentum lacking integumental projections; head capsule immediately behind mentum with 2 large circular marks, 1 each side of center; 1 or 2 setae at the basal-lateral angle of the mentum; metatrochanter not modified (Fig. 7). Sixth sternite is approximately 0.046 mm. long, the notch being just over 1/5 this length (Fig. 13). Aedeagus 0.094 mm. long × 0.46 mm. wide (Figs. 18, 19).

Female.—Unknown.

The single male (the holotype) was collected from Cecil sandy loam, WEST EDGE OF THOMASVILLE, UPSON COUNTY, GEORGIA, July 21, 1936, by W. F. Turner. The holotype (USNM 64118) is deposited in the USNM.

The configuration of the aedeagus readily separates this species from any other. It may be assumed that the female will have the same markings as the male on the anterior margin of the head capsule, and if so, this will be useful in associating the sexes.

Mayetia pearsei Schuster, Marsh, and Park, new species
(Figs. 1, 3, 4, 8, 14, 20)

Male.—Head 0.13 mm. long × 0.13 mm. wide; pronotum 0.15 mm. × 0.12 mm.; elytra 0.13 mm. × 0.12 mm.; total length 1.18 mm. As in *M. bomani*: Sensory areas of segments III and IV of maxillary palpi large (Fig. 1); left mandibular ramus with triangular tooth (Fig. 4); mentum simple except for the 2 usual setae; ventral front margin of head capsule with median circular marking and 2 setae on each side (Fig. 3); metatrochanter not modified (Fig. 8). Sixth sternite is approximately 0.067 mm. long with a small notch of about 1/5 the length (Fig. 14). Aedeagus long, thin 0.161 mm. × 0.147 mm. (Fig. 20).

Female.—As in the male except for the distal end of the abdomen which is normal for this sex as described previously.

Holotype male was collected at DUKE FOREST, DURHAM, NORTH CAROLINA by A. S. Pearse on April 28, 1945, 2 to 5 inches deep in clay soil under oaks. Eight additional male and 15 female paratypes were collected at the same locality by A. S.

Pearse from sand and clay under pines and oaks during the months of February through August, 1945. The holotype is deposited in the Illinois Natural History Survey, paratypes in the USNM and in the collections of Orlando Park and R. O. Schuster.

The 3rd and 4th segments of the maxillary palpus of both sexes have on their lateral margins large, raised, annular developments separating this species immediately from *M. bulla* and the rounded posterior edge of the metatrochanters distinguishes this species from *M. bowmani*. At least these 3 species occur in North Carolina and will probably be found together.

Mayetia domestica Schuster, Marsh, and Park, new species

(Figs. 9, 15, 21)

Male.—Head 0.13 mm. long × 0.13 mm. wide; pronotum 0.14 mm. × 0.12 mm.; elytra 0.13 mm. × 0.14 mm.; total length 1.13 mm. This species is, in general, as described for *M. bowmani*: Maxillary palpus having large annular sensory areas on segments III and IV; tooth of left mandibular ramus with triangular tooth; mentum lacking integu- anterior to each seta; the normal median circular mark with 1 long seta on each side occurs on the front ventral surface of the head capsule; metatrochanter with a small tooth midway on the inner surface (Fig. 9); sixth sternite is 0.052 mm. long, the notch 0.013 mm. (Fig. 15). Aedeagus long, thin 0.131 mm. × 0.05 mm. (Fig. 21).

Female.—Unknown.

Holotype male (USNM 64119) was collected at DEXTER, STODDARD COUNTY, MISSOURI, September 26, 1936, by W. F. Turner. It was taken from brown silt loam in a peach orchard at Crowley Ridge, and is deposited in the USNM. An additional male considered as probably conspecific but not included in the type series differs in having a mark (setal insertion?) in addition to the seta on the head capsule behind the basal-lateral angle of the mentum and in having a slightly shorter sixth sternite. It was collected at Stoddard County, Missouri on September 25, 1936 by W. F. Turner and bears the number 1213.

This species is separated by the characters of the mentum from all other species possessing sensory areas on the third and fourth segments of the maxillary palpi.

Mayetia bulla Schuster, Marsh, and Park, new species

(Figs. 2, 10, 22)

Male.—Head 0.11 mm. long × 0.12 mm. wide; pronotum 0.14 mm.

× 0.12 mm.; elytra 0.12 mm. × 0.15 mm.; total length approximately 1.01 mm. Essentially as described for *M. bowmani*: Lateral margins of maxillary palpi bearing small knob-like sensory developments (Fig. 2); left mandibular ramus with triangular tooth; mentum lacking integumental projections anterior to the pair of setae; front margin of head capsule with single circular marking and 2 lateral markings or setae on each side; metatrochanter not modified, the posterior edge rounded (Fig. 10). Sixth sternite is approximately 0.084 mm. long, the notch about 1/3 this distance. Aedeagus broad, complex, 0.121 mm. long × 0.071 mm. wide (Fig. 22).

Female.—As in the male except for the distal abdominal segment which is normal for this sex.

This species is known from 1 male (the holotype) collected from clay beneath pines at DUKE FOREST, DURHAM, NORTH CAROLINA by A. S. Pearse on August 18, 1945, and 1 female with the same data except that it was taken from sand beneath pines on July 14, 1945. The holotype is deposited in the Illinois Natural History Survey, the female paratype in the collection of Orlando Park.

Both sexes of *Mayetia bulla* may be separated from all known species by the knob-like sensory developments on the maxillary palpi.

KEY TO SPECIES OF UNITED STATES MAYETIA EXCLUDING CALIFORNIA

1 Sensory developments of maxillary palpi small knob-like structures occupying a small fraction of segments III and IV ..... *M. bulla*
Sensory developments of maxillary palpi large areas about half the length of segment IV 2

2(1) Mentum with 2 integumental projections anterior to a pair of setae ..... *M. domestica*
Mentum lacking integumental projections anterior to the pair of setae 3

3(2) Metatrochanter with inner-posterior edge rounded 4
Metatrochanter with inner-posterior edge forming a 90 degree angle or developed into a spine 5

4(3) Single median circular mark occurring behind mentum ..... *M. pearsei*
Two circular marks occurring behind mentum ..... *M. bicorona*

5(3) Metatrochanter with large inner-posterior spine ..... *M. turneri*
Metatrochanter roughly square in outline ..... *M. bowmani*

The following localities pertain to collections of *Mayetia* from which we have seen only females. Combined with the records following the species descriptions, they show the genus *Mayetia* to be widely distributed in the United States. They also point to areas in which specimens might easily be collected

by persons interested in advancing the understanding of this group. 1. Pike County, Arkansas. 2. Mount Olive, Robertson County, Kentucky. 3. Humboldt, Coles County, Illinois (natural prairie soil). 4. Matton, Coles County, Illinois. 5. Anson and Moore Counties, North Carolina. 6. Brown County, Texas. 7. Parker Islands, 7 miles S.E. of Lake Highland County, Florida.

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A NEW SPECIES OF TRAGOSOMA FROM SOUTHEASTERN ARIZONA

(Coleoptera: Cerambycidae)

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The following new species of *Tragosoma* is described at this time in order that the name may be available for use in connection with biological studies to be reported elsewhere.

Tragosoma chiricahuae Linsley, new species

Male. Form elongate, narrow, subparallel; integument dark brown, shining, sparsely pubescent. *Head* coarsely, confluently punctate; eyes narrowly separated by a distance about equal to pedicel of antennae; antennae attaining apical one-fourth to one-sixth of elytra, segments glabrous, opaque, apices produced externally, punctures fine, dense, elongate. *Pronotum* coarsely, irregularly punctate, disk irregularly elevated, shining, glabrous; pronotal margins thinly clothed with long, erect golden hairs, lateral spine

projecting forward slightly; pro-, meso-, and metasterna shining, finely, densely punctate, pubescence long and moderately dense but scarcely obscuring integument. *Elytra* subparallel; surface glabrous, shining, punctures large but less deep than those of pronotum; sutural spines much shorter than lateral spine of pronotum, slightly curved. *Legs* slender; femora sparsely hairy. *Abdomen* shining, finely not densely punctate, thinly pubescent; fifth sternite about as long as fourth, apex emarginate. Length, 23-31 mm.

Female. Form more robust than male, punctation and vestiture similar but marginal pronotal pubescence lacking; antennae attaining only middle of elytra; abdomen with fifth sternite elongate, apex entire or feebly rounded. Length, 25-34 mm.

Holotype male (California Academy of Sciences) from the Southwestern Research Station of the American Museum of Natural History, FIVE MILES WEST OF PORTAL, CAVE CREEK CANYON, 5400 ft. elevation, CHIRICAHUA MOUNTAINS, COCHISE COUNTY, ARIZONA, August 16, 1958 (J. R. Quezada), allotype female (Calif. Acad. Sci.), same locality, July 25, 1955 (P. D. Hurd, Jr.) and seven paratypes (California Insect Survey), also from the same locality, on various dates from June 20 to August 18 (J. M. and S. N. Burns, C. W. Kirkwood, C. G. Moore, P. D. Hurd, Jr.). Three additional paratypes from the Chiricahua Mountains, a male collected July 27, 1957 and two females collected August 2, 1952, are in the collection of J. N. Knull. A male from Juan Miller Campground, 17 miles north of Clifton, Blue Range of White Mountains, Greenlee County, Arizona, July 7, 1958 (J. M. and S. N. Burns, in collection of the California Insect Survey) is also assignable to this species but is not designated as a paratype.

This species resembles *T. pilosicornis* Casey in the dark color and glabrous pronotum but the average size is larger, the punctation of the pronotal disk and base of the elytra is less coarse, the antennae of the male are more opaque and densely punctate, and the sutural spines of the elytra are much shorter, being only about half as long as the thoracic spine. Aside from the dark color, glabrous pronotum, irregular pronotal disk and coarser punctation, which are similar in both sexes, *T. chiricahuae* further differs from *T. depsarius* (Linnaeus) in the narrowly separated eyes and opaque antennae of the male.

UNDESCRIBED SPECIES OF TIPULIDAE FROM THE WESTERN UNITED STATES

Part V*

(Diptera)

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The preceding part under this general title was published in the Pan-Pacific Entomologist, 26:81–85; 1950. At this time I am describing three species belonging to the genus *Tipula* from California, all collected by myself in 1953 and 1957. The major work on the crane-flies for the California Insect Survey is progressing rapidly but records for many species that should occur are still lacking and it is evident that further intensive field work must be done. I am planning to do further collecting in the state in 1958 and 1959 and any miscellaneous specimens from poorly known parts of the state and at unusual seasons would be greatly appreciated in order to complete the record.

Tipula (Bellardina) umbra Alexander, new species

Allied to *gothicana* Alexander; mesonotal praescutum with the restricted ground buffy yellow, with four discal stripes and the lateral margins brown; scutum chiefly dark brown, each lobe with a V-shaped pale mark; femora obscure yellow, tips narrowly black, claws of male toothed; wings strongly darkened, variegated by restricted darker and numerous small yellow markings; veins beyond cord with numerous macrotrichia; abdomen brownish yellow, lateral tergal borders blackened; male hypopygium with the tergite large, posterior border shallowly emarginate, with conspicuous lateral lobes, ventral surface with a median lobe directed cephalad, the apex spiculose; dististyles large, very irregular in outline.

Male.—Length about 21 mm.; wing 18.5 mm.; antenna about 3.4 mm.

Female.—Length about 20 mm.; wing 20 mm.

Frontal prolongation of head dark brown above, including nasus, more reddish brown on sides, obscure yellow beneath at base; palpi dark brown. Antennae of moderate length in both sexes; scape and pedicel obscure yellow to brownish yellow, flagellum brown; verticils much longer than the segments, basal enlargements small. Head dark brown, paler in front, orbits restrictedly pale.

Pronotum obscure yellow, with three brown areas. Mesonotal praescutum with the restricted ground obscure buffy yellow, the surface almost covered by four brown stripes that are narrowly and vaguely bordered by darker, the intermediate pair confluent at suture; humeral and lateral

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* Contribution No. 1289 from the Entomological Laboratory of the University of Massachusetts.

I wish to express my indebtedness to the National Science Foundation for financial aid in conducting field explorations in California in 1957.

margins similarly darkened, restricting the lateral interspace to a narrow line; scutum chiefly dark brown, each lobe with a V-shaped pale mark; scutellum dark brown, broadly paler posteriorly; parascutella dark brown; mediotergite light brown, posterior border with two circular pale areas. pleura and pleurotergite chiefly brown, variegated with paler. Halteres with stem brown, restrictedly reddened at base, apex of knob obscure yellow. Legs with coxae infuscated basally, broadly yellow at tips, trochanters obscure yellow, with a large brownish black spot on lower face; femora obscure yellow, tips narrowly but conspicuously black, the amount subequal on all legs; tibiae obscure yellow, tips narrowly brownish black; basitarsi brownish yellow, the outer ends, with remainder of tarsi, black; claws of male toothed. Wings with the ground strongly darkened, variegated by restricted darker brown areas and small but more numerous yellow marks; darker areas include stigma, origin of *Rs* and a spot at near one-third the length of cell *Cu;* the yellow marks occur before and beyond origin of *Rs*; poststigmal extending into cells R_3 and R_5; at cord; near outer end of cell *M*; before and beyond the darkened area in cell *Cu*, and as marginal spots in cells R_5, M_1, *2nd* M_2, M_3, and two in cell *1st A*, those in the medial field small; prearcular and costal fields slightly paler than the ground; veins yellowish brown. Veins beyond cord with numerous macrotrichia, more restricted on *M*. Venation: R_3 sinuous, narrowing the cell at near midlength; cell *1st* M_2 small, subpentagonal; petiole of cell M_1 and *m* subequal.

Abdominal tergites brownish yellow, lateral borders conspicuously blackened, posterior margins of segments narrowly pale; basal sternites of male clearer yellow, outer segments more darkened; hypopygium yellowish brown. Ovipositor with valves elongate; cerci castaneous, gently upcurved, tips obtuse; hypovalvae compressed, yellow. Male hypopygium with the tergite large, narrowed posteriorly, the apex shallowly emarginate, with conspicuous lateral lobes; on ventral surface with a large fleshy lobe directed cephalad, the apex spiculose. Two dististyles, both very irregular in outline, the outer style larger, at apex produced into two lobes or blades, before tip with a further flattened blade subtended outwardly by a slender rod; inner style nearly as large, appearing as a slightly curved flattened blade, the concave inner margin at near midlength produced into a point. Gonapophyses appearing as two every slender rods, longer than the sheath of the aedeagus; what appears to be the outer part of this organ lies detached in the type slide, appearing as a slender sclerotized rod.

Holotype male, CASTLE CRAGS STATE PARK, SHASTA COUNTY, CALIFORNIA, 2000 ft., July 6, 1953 (Alexander). Allotopotype female, pinned with type.

The nearest ally is the generally similar *Tipula (Bellardina) gothicana* Alexander, which is widely distributed in western America and readily distinguished by the quite different male hypopygium, especially the tergite and dististyles.

Tipula (Lunatipula) twightae Alexander, new species

Allied to *perfidiosa* Alexander; antennal flagellar segments of male

strongly incised; mesonotal praescutum with three orange-yellow stripes, the interspaces slightly darker; wings weakly suffused with brown, the prearcular and costal fields more brownish yellow, darkened pattern inconspicuous; abdomen obscure yellow, outer segments darker; inner dististyle of male hypopygium without a dorsal crest, lower beak well-developed; outer basal lobe much as in *perfidiosa*.

Male.—Length about 15 mm.; wing 15 mm.; antenna about 5 mm.

Frontal prolongation of head brownish yellow, nasus conspicuous; palpi with basal segments testaceous yellow, outer segments black. Antennae of male relatively long, as shown by the measurements; basal three segments obscure yellow, remaining segments vaguely bicolored, the basal enlargements black, the remainder brown; segments a trifle longer than the verticils; flagellar segments very strongly incised, the long outer swelling being fully as deep as the short-oval basal enlargement. Head gray, clearer gray in front and on the narrow orbits; vertex with the central area narrowly darker brown, narrowed to a point behind, without setae.

Pronotum buffy yellow. General coloration of mesonotum orange-yellow, including the three praescutal stripes, the interbases slightly darker brown; centers of scutal lobes similarly orange-yellow; scutellum and mediotergite sparsely pruinose, the former with a vague capillary darker line. Pleura buffy yellow, sparsely pruinose. Halteres with stem obscure yellow, knob darkened. Legs with coxae buffy, sparsely pruinose; trochanters yellow; femora and tibiae obscure brownish yellow, tips narrowly and inconspicuously darker brown; tarsi dark brown to brownish black; claws of male long, toothed. Wings weakly suffused with brown, prearcular and costal fields more brownish yellow; stigma pale brown, relatively inconspicuous; darkened wing pattern very reduced, including small brown areas at origin of *Rs* and over anterior cord; centers of outer cells vaguely darkened; obliterative area at cord relatively conspicuous, extending from before stigma into base of cell M_3; veins brown, more brownish yellow in the prearcular and costal areas. Venation: *Rs* more than twice R_{2+3}; petiole of cell M_1 shorter than *m*; *m-cu* at fork of M_{3+4}, the latter short, less than one-half *m*.

Abdominal tergites obscure yellow, clearer basally, sternites still clearer; outer subterminal segments more darkened. Male hypopygium with the tergite deeply emarginate on both the posterior and cephalic borders, the former produced into two lobes, margins narrowly sclerotized and microscopically roughened; on ventral surface of plate on either side with a V-shaped carina, the margins roughened. Ninth sternite with a complex bilobed appendage on either side of the aedeagus. Basistyle with its dorsal end produced into a slender arm adjoining the sternite. Outer dististyle elongate, gently widened at outer end, the margin fringed with long conspicuous black setae; inner style with the main body relatively narrow, beak very slender at outer end, lower beak much stouter; no developed dorsal crest as in some allied species; outer basal lobe generally as in *perfidiosa* and *modoc* Alexander, appearing as a flattened plate, the outer third narrowed into a long slender spine, surface of expanded basal part

with long pale setae; sensory pits in a compact group at base between the body of style and the outer basal lobe. Phallosome appearing as a flattened blade that is produced into paired blackened points. Eighth sternite sheathing, narrowed outwardly, the truncated posterior border with two triangular groups of long brownish yellow setae, the hairlike tips pale and conspicuously twisted.

Holotype male, CASTLE CRAGS STATE PARK, SHASTA COUNTY, CALIFORNIA, 2000 ft., July 8, 1953 (Alexander).

I take great pleasure in dedicating this interesting crane-fly to Mrs. Mary Twight (Mrs. Benjamin Twight), former custodian of the Castle Crags State Park, to whom we are indebted for many kindly favors. Mrs. Twight is a capable botanist who has made many interesting plant discoveries in and near Castle Crags. The type of this interesting fly was taken along small streamlets that flowed into the Sacramento River at the park. It was closely associated with the striking phantom orchid or silver slipper, *Cephalanthera Austinae* (Gray), that was numerous and in full flower at this date.

The fly is related to species such as *Tipula (Lunatipula) perfidiosa* Alexander, *T. (L.) modoc* Alexander and *T. (L.) macnabi* Alexander, all with somewhat similar antennae and having the general plan of the male hypopygium the same, differing very conspicuously in the details of structure of the latter, particularly the tergite and inner dististyle.

Tipula (Lunatipula) leiocantha Alexander, new species

Belongs to the *impudica* group, allied to *carunculata* Alexander; mesonotal praescutum grayish yellow with a broad fulvous brown central stripe that is narrowly margined laterally with dark brown; femora obscure yellow, tips narrowly darkened; wings strongly tinged with brown, restrictedly patterned with darker brown and subhyaline areas; male hypopygium having the tergal canthi with smooth margins; inner dististyle with the lower apical appendage nearly as long as the remainder of style; eighth sternite with posterior border subtruncate, very densely fringed with long yellow setae.

Male.—Length about 15–16 mm.; wing 15–16.5 mm.; antenna about 4.3–4.5 mm.

Frontal prolongation of head elongate, polished brownish yellow; nasus very short; palpi with basal three segments brownish yellow, terminal segment dark brown. Antennae moderately long, as shown by the measurements; scape and pedicel light yellow, flagellum brownish black to black; flagellar segments exceeding the verticils in length; basal enlargements well-developed. Head grayish brown, clearer gray on front and the very narrow orbits; a capillary dark brown central vitta extending from the low vertical tubercle backward.

Pronotum obscure yellow, vaguely patterned with pale brown areas. Mesonotal praescutum obscure grayish yellow, patterned with fulvous brown and dark brown; a broad fulvous brown central stripe, narrowly margined laterally with dark brown; lateral stripes dark brown; setae of interspaces darkened; scutum grayish yellow, each lobe with two brown areas, the anterior one very small; scutellum grayish yellow with a central darkening and a less evident lateral spot near base; mediotergite grayish yellow, more or less patterned with reddish brown on central and posterior parts; pleurotergite with the katapleurotergite darker than the anapleurotergite. Pleura brownish yellow, vaguely patterned with darker. Halteres with stem brownish yellow, clearer yellow basally, knob dark brown. Legs with the coxae and trochanters obscure yellow; femora obscure yellow, tips narrowly darkened; tibiae and tarsi brownish yellow, the outer tarsal segments passing into dark brown; terminal tarsal segment with a blackened ventral spot; claws of male toothed. Wings strongly tinged with brown, somewhat darker in outer radial field and over *m-cu;* a restricted darkening near midlength of cell 2nd *A* at margin; stigma darker brown; obliterative areas whitened but relatively inconspicuous, poststigmal brightening more yellowed; veins brown. Venation: Petiole of cell M_1 subequal to or shorter than *m*.

Abdominal tergites polished yellow; a narrow, nearly continuous median brown vitta; lateral borders broadly light gray, margined internally by a narrow broken darkened line, in some cases this is evident only on the basal ring of the segment; sternites yellow, outer segments slightly darker; hypopygium brownish yellow. Male hypopygium generally as in *lyrifera* Dietz and allies. Ninth tergite with a narrow median incision, the canthi triangular, subacute at tips, margins entirely smooth; inflexed lateral parts subtriangular in outline; subtergal process parallel-sided, the apex extended into pale membrane. Basistyle with the apical sclerotized point short but slender. Outer dististyle broad basally, strongly narrowed on outer half; inner style with the beak obtuse; lower apical appendage nearly as long as the remainder of style, appearing as a straight flattened blade, the inner margin with a few weak scattered setae, the outer margin of basal half with abundant delicate setae. Eighth sternite with the posterior border subtruncate, very densely fringed with long yellow setae.

Holotype male, Big Pine Creek, Inyo County, California, on sage-covered hillsides at Glacier Lodge, 7800 ft., July 11, 1957 (Alexander). Paratopotypes, two males, July 10–11, 1957. Associated with *Tipula (Lunatipula) mono* Alexander.

The described species of the *impudica* group that have the lower apical appendage of the inner dististyle of the male hypopygium greatly lengthened as in the present fly, include *Tipula (Lunatipula) carunculata* Alexander, *T. (L.) diversa* Dietz and *T. (L.) lyrifera* Dietz, all differing among themselves in coloration of the body and wings and especially in the structure

of the male hypopygium. The present fly is best told from *carunculata* by the hypopygial characters, including the entirely smooth tergal canthi.

AN EMERGENCE NOTE ON THE ROUNDHEADED CONE BORER, PARATIMIA CONICOLA FISHER

(Coleoptera: Cerambycidae)

In September of 1956, a series of cones of the knobcone pine, *Pinus attenuata* were collected from an area nine miles west of Lakeport, Lake County, California. These cones were judged to be two years old at the time of collection, that is 1954 was the assumed year of maturation.

The cones were brought into Berkeley and placed in a half gallon cardboard ice cream container, a device used in cone-insect rearing studies. The container was kept in an outdoor screened insectary.

On February 15, 1957, a single adult of *Paratimia conicola* Fisher emerged from one of the cones. On March 12, of the same year, two more beetle adults emerged, one from the cone of the previous emergence and the second from another cone. On April 16, 1958, a single female beetle emerged from the cone which had produced the two beetles in the year before, and on March 10, 1959, still another female emerged from the cone which had produced three beetles in the past two years. There were no emergence holes in the cones at the time of collection.

These results suggest that the period of larval development in this species is variable, a factor which might contribute to survival of the species in years when few cones are available for oviposition. It is possible, however, that the cones were older than they appeared to be and that they may have been attacked by females in more than one season, or that conditions in the rearing container retarded the development of certain of the larvae.—HERBERT RUCKES, JR., *University of California, Berkeley.*

SOME NOMENCLATORIAL PROBLEMS IN THE GENUS XYLOCOPA LATREILLE

(Hymenoptera: Apoidea)

PAUL D. HURD, JR.
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A sound nomenclatorial foundation is a fundamental and an absolutely essential requisite for any well-executed taxonomic study. Obviously, it follows that any investigation dependent upon this foundation can only reflect it. Consequently, it is incumbent on those individuals providing these nomenclatorial bases to thoroughly, albeit exhaustively, investigate each nomenclatorial proposal before it is made. An investigator who fails to recognize or even consider the eventual ramifications within the sphere of knowledge that his proposal may have, clearly demonstrates a genuine lack of concern for future endeavors. It should be remembered that in the final analysis a name serves as a basis for the accumulation of information. Intelligent progress depends on this association and moreover demands it. Inattention to these matters, for whatever reason, not only hinders and confuses progress but invites such poignantly critical views as those expressed by Stärcke (1953) in his satirical essay on nomenclature.

An examination of the literature pertaining to the members of the genus *Xylocopa* Latreille (including *Mesotrichia* Westwood) reveals that there have been more than 700 names applied which involve a rather considerable bibliographic history. A number of nomenclatorial problems require attention and this opportunity is taken so as to facilitate their handling in a forthcoming paper. Since the number of homonymic names applied in the genus is relatively great, a listing of these is presented in summary form. In view of the uncertain zoological status of *Mesotrichia* Westwood (present studies tend to support the view that it is an African subgenus of *Xylocopa* containing less than a dozen species) no nomenclatorial changes affecting the names proposed in *Mesotrichia* are made.

I am indebted to Dr. M. A. Lieftinck, Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands for reviewing the manuscript and offering particularly valuable advice.

The following name changes are effected for currently existing primary homonymic names which represent bona fide (i.e.

zoologically valid) members of the genus *Xylocopa* Latreille:

Xylocopa nigrella Hurd, nom. nov.

Xylocopa nigrella Hurd, *nomen novum pro Xylocopa caffra nigrescens* Maidl, 1912, Ann. K. K. Naturhist. Hofmus., Wien, 26: 283, 330 ("... 2 ♂, das eine aus Mikindani . . ., das andere aus W.–Usambara . . ."), *nec Xylocopa aestuans* var. *nigrescens* Friese, 1901, Die Bienen Europa's, 6: 227 (female, "Borneo"), *nec Xylocopa sauteri* var. *nigrescens* Friese, 1910, Verhandl. der K.K. Zool.–Bot. Gesellsch., 60: 410 (male, "Formosa").

Since Maidl (1912:283) did not select one of the two males as the holotype, I designate his first cited male (Mikindani, [Tanganyika Territory]) to serve this purpose. *X. nigrella*, while clearly a member of the *Xylocopa caffra* (Linnaeus) group, is a distinct species assignable to the subgenus *Koptortosoma* Gribodo.

I have been unable to determine satisfactorily the zoological status of *Xylocopa aestuans* var. *nigrescens* Friese which was described from "Borneo." The *Xylocopa* of Borneo (including Sarawak) are rather poorly known. Apart from the description of several new taxa, its carpenter bee fauna has been investigated only coincidental with taxonomic studies of other geographic areas. From the description afforded by Friese (1901:227) it seems very improbable that this carpenter bee is to be associated with *X. aestuans* (Linnaeus). Its correct status, however, must await future studies.

It should be noted that the Sarawak *Xylocopa caerulea* var. *viridis* Meade-Waldo (1916:465) is preoccupied by *X. viridis* Smith (1854:360) from Brazil. Dr. M. A. Lieftinck informs me that *viridis* Meade-Waldo is correctly placed as a color variety of *X. (Cyaneoderes) caerulea* (Fabricius), a position also held by Maa (1939:94,95). Since Van der Vecht (1953:67) has recognized a "local form" or subspecies of *X. caerulea* from Bangka Island it seems altogether probable that the preoccupied *viridis* Meade-Waldo may prove to be a subspecies and accordingly is renamed.

Xylocopa caerulea meade-waldoi Hurd, nom. nov.

Xylocopa caerulea meade-waldoi Hurd, *nom. novum pro Xylocopa caerulea* var. *viridis* Meade-Waldo, 1916, Ann. Mag. Nat. Hist. (8) 17:465 (female, "Sarawak: Kuching"), *nec Xylocopa viridis* Smith, 1854:360, (male, "Hab. Brazil (Rio Tapajos)").

Xylocopa isabelleae Hurd, nom. nov.

Xylocopa isabelleae Hurd, *nomen novum pro Xylocopa eximia* Friese, 1908, Deutsche Ent. Zeitschr. p. 569 (female, "von Ikutha, 1000 m, Brit.

Ostafrika"), *nec Xylocopa eximia* Pérez, 1901, Actes Soc. Linn. Bordeaux, 56 (ser. 6, vol. 6): 87–88 (female, "Bolivie").

This species, which I take pleasure in dedicating to my wife Grace Isabelle, belongs to the subgenus *Koptortosoma* and is apparently related to *Xylocopa lateritia* Smith, 1854:346, a species originally described from the "Isle of Johanna (Mozambique)." The Neotropical species, *Xylocopa eximia* Pérez, 1901:87 is a member of the subgenus *Neoxylocopa* Michener and is related to species of the "*similis* group" (Moure, 1949:455–458).

Resurrection from synonymy of *Xylocopa ocularis* Pérez, 1901 is necessitated by the discovery that the Lesser Sunda Islands *Xylocopa dimidiata* Lepeletier, 1841 is a primary homonym of the earlier described Neotropical *X. dimidiata* Latreille, 1809.

XYLOCOPA OCULARIS Pérez, new status

Xylocopa dimidiata Lepeletier, 1841, Histoire naturelle des insectes. Hyménoptères, 2:199 (female, "Ile de Timor"), *nec* Latreille, 1809:95. *New Synonymy.*

Xylocopa ocularis Pérez, 1901, Actes Soc. Linn. Bordeaux, 56 (ser. 6, vol. 6):62–63 (female, "Timor").

For some curious reason the work of Latreille (1809), in which two new species of *Xylocopa* (*X. chrysoptera*, p. 93 and *X. dimidiata*, p. 95) were described, appears not to have been directly consulted by specialists of this group, except by Pérez (1901:71–73), since the time of Smith (1874:287). If Cockerell (1907:228) had done so he most assuredly would not have proposed *Xylocopa batesi* under the circumstances that: "*X. dimidiata* Lep. is from Timor; . . . *X. dimidiata* Smith, Trans. Ent. Soc. Lond., 1874, p. 287, from Ega on the Amazons, may take the name *X. batesi*, n. n.". In any event *Xylocopa dimidiata* Latreille, 1809:95 preoccupies *X. dimidiata* Lepeletier, 1841:199 and since both are zoologically valid members of the genus *Xylocopa* Lepeletier's preoccupied name should be replaced with *Xylocopa ocularis* Pérez, 1901:62, which has been shown by Van der Vecht (1953:68) to be equivalent zoologically to it. Lieftinck (1955:25–27) has treated this species in some detail and has provided an excellent illustration of the male genitalia.

Certain matters connected with the nomenclature of *Koptortosoma* Gribodo and *Schönherria* Lepeletier require attention if the manifold taxonomic problems associated with these cate-

gories are to be cogently pursued. Toward achieving that end the following is offered as at least a partial solution of this situation.

Subgenus KOPTORTOSOMA Gribodo

Koptortosoma Gribodo, 1894, Bull. Soc. Ent. Italiana, 26:271 (type: *Koptortosoma* gabonica Gribodo, 1894:272 designated by Sandhouse, 1943, Proc. U. S. Natl. Mus., 92:561).

Koptorthosoma Dalla Torre, 1896, Cat. Hymen., 10:202 (emendation *pro Koptortosoma* Gribodo, 1894:271).

Coptorthosoma Pérez, 1901, Actes Soc. Linn. Bordeaux, 56 (ser. 6, vol. 6): 3 (emendation *pro Koptortosoma* Gribodo, 1894:271 and *Koptorthosoma* Dalla Torre, 1896:202.).

Orbitella Ma[a], 1938, Rec. Indian Mus., 40:270, 305 (type: *Xylocopa confusa* Pérez, 1901:39, 57), *nom. praeocc., nec Orbitella* Douvillé, 1915.

Maiella Michener, 1942, Jour. New York Ent. Soc. 50:282, *nom. nov. pro Orbitella* Ma[a], 1938, *nec Orbitella* Douvillé, 1915 = *Coptorthosoma* Pérez, 1901, *teste* Maa, 1954, Vidensk. Meddel. Dansk Naturhist. For. Kobenhavn, 116:192; zoological status yet to be determined, *teste* Lieftinck, 1957, Nova Guinea, new ser., 8(2):325.

Euryapis Sandhouse, 1943, Proc. U. S. Natl. Mus., 92 (3156):551, *nom. nov. pro Orbitella* Ma[a], 1938, *nec* Douvillé, 1915, antedated by *nom. nov. Maiella* Michener, 1942:282, q. v.

As noted above, Sandhouse (1943:561) designated *Koptortosoma gabonica* Gribodo (1894:272) as the type of *Koptortosoma* Gribodo. Cockerell (1930:299–300) in his comment concerning "*Mesotrichia stanleyi* (LeVeque)" states: "This is undoubtedly the male described as *M. gabonica* (Gribodo); but the female of *gabonica*, first described, must stand as the type and I am not sure that the sexes are correctly associated." Following this action any interpretation to determine the zoological status of *Koptortosoma* Gribodo must be founded first upon the characteristics of the Cockerell designated lectotype (female) of *Koptortosoma gabonica* Gribodo.

Most assuredly the emendations *Koptorthosoma* Dalla Torre and *Coptorthosoma* Pérez were unnecessarily proposed for *Koptortosoma* Gribodo. In this connection, Dr. M. A. Lieftinck (*in litt.*) points out: "I can not see why these emendations should be accepted, since *Koptortosoma* is a validly proposed name, not a lapsus calami, and Gribodo even gave an explanation of the name, leaving no rights to an emendation."

The zoological status of the subgenus *Koptortosoma*, which currently embraces a large number of species (approximately 215 names applied) chiefly distributed in the Ethiopian, Oriental,

and Australo-Papuan Regions, cannot be satisfactorily determined until the question of its correct type species is established. Vitzthum (1930:314ff) concludes that the type of *Koptortosoma* Gribodo, 1894:271 is *Xylocopa aestuans* (Linnaeus), 1758:579 (one of the several species included by Gribodo in his original proposal), but states that it really doesn't matter (p. 315) since the Oriental and African forms agree in general characteristics. Vitzthum redefines the subgenus largely by the addition of a geographical qualification so as to exclude certain New World species which would fit Gribodo's original diagnosis and further by a statement of the mites (*Dolaea*, currently *Dinogamasus*) intimately associated with these Old World carpenter bees. As Vitzthum *(ibid.)* so appropriately declares, recognition of *Xylocopa aestuans* (Linnaeus) as the type species presents certain difficulties because of the inexact type locality given by Linnaeus for *X. aestuans, viz.*, "*Habitat in* calidis *regionibus.*"

Obviously, if Vitzthum's type designation of *Xylocopa aestuans* (Linnaeus) is construed as valid and therefore takes precedence over that (*Koptortosoma gabonica* Gribodo) later provided by Sandhouse (1943:561) it appears to me that unnecessary complications are introduced into an already confounded situation. In view of this it seems to me that greater uniformity and less confusion would result if *Koptortosoma* Gribodo with *Koptortosoma gabonica* Gribodo as its type species be rigidly accepted.

Not infrequently *Mesotrichia* Westwood (1838:112) has been used interchangeably with and sometimes to supplant *Koptortosoma* Gribodo (including also its variant spellings). Cockerell (1906:364) concluded that it is sufficiently distinct from *Xylocopa* to be maintained as a genus and he regarded "*Koptorthosoma*" as a subgenus of it. In his subsequent papers, as well as those of his pupil Miss Norma LeVeque, *Mesotrichia* was consistently accorded generic status and consequently all those species described or assigned to *Koptortosoma* were included in it. Maa (1940: 136–137) has discussed the scope and status of *Mesotrichia* and "*Coptorthosoma*" and more recently (Maa, 1954:192) indicates that *Mesotrichia* is probably to be recognized as an independent genus. Maa *(ibid.,)* also indicates that the subgenus *Platynopoda* Westwood possibly also is to be

removed from the genus *Xylocopa* and accorded generic status.

My present investigations, however, tend to support a classification wherein *Koptortosoma* Gribodo, *Mesotrichia* Westwood, and *Platynopoda* Lepeletier are considered as subgenera of the genus *Xylocopa*. This view is supported by the existence of intermediate evolutionary units, many of which already have been characterized as subgenera, which serve to interconnect and emphasize the relationships existing within the genus *Xylocopa*. In this arrangement *Mesotrichia* Westwood embraces less than a dozen Ethiopian species typified by *Xylocopa torrida* (Westwood).

Subgenus SCHÖNHERRIA Lepeletier

Schönherria Lepeletier, 1841, Histoire naturelle des insectes. Hyménoptères, 2:207 (type *Xylocopa (Schönherria) micans* Lepeletier, 1841:208 designated by Sandhouse. 1943, Proc. U. S. Natl. Mus., 92:598).

Maa (1954:192) has incorrectly stated that Sandhouse (1943:598) designated *Apis latipes* Drury as the type species of *Schönherria* Lepeletier. Sandhouse (1943:529) did, however, designate that species as the type species of *Audinetia* Lepeletier and consequently *Audinetia* and not *Schönherria*, as he stated, is the "isogenotypic" synonym of the earlier proposed *Platynopoda* Westwood.

Since Lepeletier and Serville (1828) founded their Australian carpenter bee genus *Lestis* on specimens contained in the "... cabinet du Roi ..." (p. 799) (and not on the Fabrician type of *Apis muscaria*) and moreover misidentified their specimens as constituting the sexes of *Centris muscaria* (Fabricius) [i.e. *Apis muscaria* Fabricius, 1775, = *Xylocopa muscaria* (Fabricius), *teste* Smith, 1854:364, and a recent examination of the type by Padre J. S. Moure who finds it to be a South American *Xylocopa* assignable to the subgenus *Schönherria* and is not from "Habitat in nova Hollandia" as Fabricius (1793:339) subsequently gave as the type locality], a petition has been submitted to the International Commission on Zoological Nomenclature by Dr. C. D. Michener and the author requesting that the name *Lestis* be preserved for the Australian bees for which Lepeletier and Serville intended to provide a generic name. It seems almost unnecessary to mention the confusion that would result if it were necessary to transfer under the Rules of Zoological Nomenclature the name *Lestis* from these

Australian carpenter bees and apply it to the American carpenter bees belonging to the subgenus *Schönherria* Lepeletier.

At this writing no less than 25 names are involved in homonymic conflicts. All except three of the combinations are the result of primary homonymy involving members zoologically assignable to the genus *Xylocopa*. The exceptions are cases of secondary coexistent homonymy which have been occasioned by reasons of change in zoological generic assignment. Fortunately the preponderance of names applied in the genus *Xylocopa* has provided a sufficient number of available synonyms which serve to replace many of these. For some strange reason both Friese and Vachal (see below) appear to have proposed anew names previously so proposed by them. Indeed, it appears that most, if not all, of these double proposals are absolute synonyms as well as homonyms of the earlier names in question. It must be recognized, however, that since differing type locality statements are offered by these authors for each of their conflicting homonymic pairs an element of doubt exists concerning the synonymical equivalency of the names involved. Final solution of this problem must rest with an examination of the types concerned.

The following listing presents a summary of the homonymic conflicts known to exist in the genus *Xylocopa*. Those names which are now regarded as established synonyms or renamed homonyms are italicized. Superimposed on the list of names are the pertinent bibliographic references together with a statement of the type locality as given by its author, and in the case of synonyms or renamed homonyms an indication of its current taxonomic status.

HOMONYMIC COMBINATIONS IN THE GENUS XYLOCOPA LATREILLE

albohirta Friese, 1911:687 ("1 ♀ vom südlichen Kongogebiet").

albohirta Friese, 1922:7 ("♀ von Katanga (Kongo), Westafrika"), ? = albohirta Friese, 1911:687.

caerulea (Fabricius), 1804:345 ("Habitat in nova Caledonia", ♀), locality erroneous, *teste* Cockerell, 1911:178.

caerulea Illiger, 1806:150 ("3. *Xylocopa caerulea* Nob. Brasilien. Sie ist um die Hälfte kleiner als *Violacea*, schmaler und unterscheidet sich von ihr durch einen Leib."), ? = lucida Smith, 1874:290; *nec.* "s. descr." as stated by Dalla Torre, 1896:207.

capensis Spinola. 1838:519 ("Cap de Bonne–Esperance", ♂).

capensis Lepeletier, 1841:179 ("Cap de Bonne Esperance", ♂ ♀), = capitata Smith, 1854:348. *New synonymy.*

capensis Enderlein, 1903:56 ("Capland, 4♀. Port Natal, 1♀"), renamed enderleini Schulz, 1906:251.

dimidiata Latreille, 1809:95 ([South America, ♀]).

dimidiata Lepeletier, 1841:199 ("Ile de Timor", ♀), = ocularis Pérez, 1901:62, *ante* p. 137.

eximia Pérez, 1901:87 ("Bolivie", ♀).

eximia Friese, 1908:569 ("von Ikutha, 1000 m, Brit. Ostafrika", ♀), renamed isabelleae Hurd, *ante* p. 136.

fasciata Lepeletier, 1841:202 ("Du Brésil", ♂), = frontalis (Olivier), 1789:64, *teste* Smith, 1874:284.

fasciata Eversmann, 1854:198 ("Vorkommen: die südlichen Kirgisensteppen"), renamed zonata Alfken, 1930:78, recently assigned to the genus *Proxylocopa*, *teste* Maa, 1954:194.

femorata Fabricius, 1804:339 ("Habitat in Algier", ♂), = violacea (Linnaeus), 1758:578, *teste* Maa, 1954:217; Dalla Torre & Friese, 1894: 56; Friese, 1901:202, *et al.*

femorata Smith, 1874:262 ("*Hab.*–Algeria", ♂), *nomen novum pro grisescens* Smith, 1854:347, *nom. praeocc., nec* grisescens Lepeletier, 1841:178, renamed *commixta* Dalla Torre and Friese, 1894:56, = *cirtana* Lucas, 1846:167, *teste* Friese, 1901:218, = amedaei Lepeletier, 1841:188, *teste* Vachal, 1899:109.

frontalis (Olivier), 1789:64 ("Elle se trouve à Cayenne", ♀).

frontalis Reiche and Fairmaire, 1847:455 ("[Abyssinie]", ♂♀), renamed carinata Smith, 1874:265.

fulvopilosa Friese, 1909:230 ("Kamerun, Togo", ♂ ♀).

fulvopilosa Friese, 1922:7 ("♂ ♀ von Kamerun, ♀ Bipindi"), ? = fulvopilosa Friese, 1909:230.

grisescens Lepeletier, 1841:178 ("Patrie inconnue", ♀, = "*Hab.*–Brazil"), *teste* Smith, 1874:286.

grisescens Smith, 1854:347 ("Hab. Algeria", ♂), renamed *femorata* Smith, 1874:262, *nom. praeocc., nec* Lepeletier, 1841:178, renamed *commixta* Dalla Torre and Friese, 1894:56, = *cirtana* Lucas, 1846:167, *teste* Friese, 1901:218, = amedaei Lepeletier, 1841:188, *teste* Vachal, 1899:109.

namaquaensis Friese, 1911:687 ("2♂ von Ookiep (Kl. Namaland)").

namaquaensis Friese, 1922:7 ("♂ von O'okiep (Kl. Namaland), Willowmore, Südafrika"), ? = namaquaensis Friese, 1911:687.

nigrescens Friese, 1901:227 ("Borneo", ♀).

nigrescens Friese, 1910:410 ("♂ [Formosa]"), = sauteri Friese, 1910: 409, *teste* Yu, 1954:2.

nigrescens Maidl, 1912:283 (" . . . 2♂, das eine aus Mikindani [herewith selected as the holotype], das andere aus W.–Usambara, [both localities in east Africa]"), renamed nigrella Hurd, *ante* p. 136.

nigriceps Friese, 1903:207 ("1♀ von Sierra Leone").

nigriceps Friese, 1922:8 ("♀ von Sierra Leone [herewith selected as the holotype] von der Elfenbeinküste und auch von Usambara, also westafrika und Ostafrika"), = nigriceps Friese, 1903:207, *teste*

Hedicke, 1923:431.

nigriceps Friese, 1922:9 ("♀ von Dibongo in Südkamerun, Westafrika"), renamed dibongoana Hedicke, 1923:431.

olivacea (Fabricius), 1787:300 ("Habitat in Sierra Leon, Africae", ♂), = caffra (Linnaeus), 1767:959, *teste* LeVeque, 1928:3.

olivacea Spinola, 1838:519 ("Indes–Orientales et Java", ♂), ? = confusa Pérez, 1901:39, 57, *teste* Maa, 1938:313.

penicillata Maidl, 1912:308 ("1♂ aus Annam (Phoc Son)"), = phalothorax Lepeletier, 1841:194, *teste* Maa, 1940:131.

penicillata Enderlein, 1913:169 ("Columbien, 1♂"), renamed maidli Maa, 1940:132.

quadrimaculata Meunier, 1892:64 ("Quito, Capture à 2000 meters de hauteur", ♂).

4–[*i.e. quadri–*] *maculata* Friese, 1916:328 ("♂ ♀ von Mexiko (Jacubaya) [=Tacubaya!, D. F. México; ♂ selected as the holotype], ♀ von America centr. (Chiriqui)"), = azteca Cresson, 1878:228. *New synonymy*

rejecta Vachal, 1910:320 ("Vu quatre ♀ et deux ♂ de l'Afrique orientale anglaise (Nairobi, Escarpment)").

rejecta Vachal, 1922:987 ("Afrique Orientale Anglaise.–Naivasha; Nairobi et Escarpment, 4♀; Escarpment aout, 2♂"), ? = rejecta Vachal, 1910:320.

rufotegularis Cockerell, 1947:144 (" . . . Feira, N. Rhodesia . . .", ♂).

rufotegularis Michener, 1954:157 ("*Canal Zone:* Culebra–Arraiján trail", ♀ [type], ♂) = ecuadorica Cockerell, 1909:403. *New synonymy*

senex Friese, 1909:242 ("Tanganjika–See, Madagaskar", ♀).

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serripes Burmeister, 1876:156 (" . . . bei Rio Janeiro (Laranjeiras, im Garten meines Freundes Lallemant) fing . . .", ♂♀).

serripes Hedicke, 1938:189 ("1♀ (Holotypus) Iran: Bushire"), renamed hedickei Maa, 1940:131, = fenestrata (Fabricius), 1798:273, *teste* Maa, 1954:221.

virescens Lepeletier, 1841:186 ("De Cayenne", ♀).

virescens Gistel, 1857:29 ("Italien" ♀), renamed virescentis Strand, 1917:98.

viridis Smith, 1854:360 ("Hab. Brazil (Rio Tapajos)" ♂).

viridis Meade–Waldo, 1916:465 ("Sarawak: Kuching", ♀), renamed meade–waldoi Hurd, *ante* p. 136.

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A NEW NAME PROPOSED IN THE GENUS THEREVA

(Diptera: Therevidae)

In my revision of the Therevidae (1923)[1], I proposed in the genus *Thereva* the name *pygmaea* for a small, hairy-faced therevid fly found in the mountains of southern California. It is one of a curious little group of related species, along with *melanoneura* Loew, *anomala* Adams and *xanthobasis* James.

Paul H. Arnaud, Jr., has called my attention to an older use of the name *Thereva pygmaea* in what is now the family Tachinidae. *Thereva* is an ancient name and was first used, like *Bibio* and *Musca*, in a very broad sense. *Thereva pygmaea* Fallén is the genotype of *Catharosia* Rondani (1820. Dipt. Suec. Rhiz., 4).

I propose the name *nana* for this little therevid fly, described as *T. pygmaea* (pages 89–90).—FRANK R. COLE, *University of California, Berkeley.*

[1] Cole, F. R., 1923. A Revision of the Therevidae. Proc. U.S. Nat. Mus. 62:1-140.

A NEW GENUS OF NORTH AMERICAN FRUIT FLIES

(Diptera: Tephritidae)

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Quisenberry's (1950) revision of the tephritid genus *Euaresta* characterizes the North American species as having, in addition to other features, swollen male fore femora, two pairs of lower frontoorbitals, dorsocentrals closer to the suture than to a transverse line between the supraalars, two pairs of scutellars, and a paired set of striations near the anal region of the claspers of the external male genitalia. The holotypes of three Coquillett species —*Trypeta (Euaresta) californica* (1894), *Euaresta munda* (1899), and *Euaresta mundula* (1899)—agree in all but the last two of these characters, and but for them probably should be placed in *Euaresta*. However, further study of this Coquillett material and of additional specimens from Colorado, Idaho, and California has brought to light other differences from *Euaresta* which justify the proposal of a new genus.

Valentibulla[2] Foote and Blanc, new genus

Type species: *Trypeta (Euaresta) californica* Coquillett, 1894.

Generic characters.—Anterior oral margin not produced beyond flat whitish-pollinose face; proboscis not geniculate; two pairs of upper frontoorbitals. Humerals and supraalars present; no presutural dorsocentrals; one pair postsutural dorsocentrals, situated closer to suture than to transverse line between the supraalars; one pair well developed scutellars; head and mesonotum with abundant, stout, white to yellowish-white setae. Abdomen, including external male genitalia and ovipositor sheath, dark brown to black, highly polished; male without *Euaresta*-like grooves near the anal region of external claspers; the proximal two-thirds or three-fourths of ovipositor sheath of female distinctly swollen in contrast to the rather suddenly narrowed distal third or fourth. Fore femora of male swollen to at least 1.5 times the diameter of mid and hind femora. Wing as in figs. 4, 5, and 6, with hyaline spots in a dark brown disc; a distinct, large bulla present in cell R_5; vein R_{4+5} sinuate distad of the m-cu crossvein and curved forward at its termination in the costal margin; middle marginal hyaline spot in cell R_1 usually extending across vein R_{2+3} into cell R_3.

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[1] Assistance in this study was obtained from the University of California at Riverside, the California Academy of Sciences, Stanford University, and the Museum of Comparative Zoology, Harvard University.

[2] *Valentibulla*: from the Latin *valentis*, meaning strong, referring to the prominent bulla in cell R5. The name was originally proposed by Quisenberry in an unpublished manuscript.

The most characteristic features of this genus are the flat or rather tumid white-pollinose face, which terminates anteriorly without any anterior production of the oral margin (figs. 1, 2, and 3); the highly polished, dark brown to black abdomen, exterior male genitalia and ovipositor sheath, the prominent bulla; and in most specimens the extension of at least the middle marginal hyaline spot in cell R_1 across vein R_{2+3} into cell R_3.

The genus is closely related to *Euaresta,* from which it may be separated by the absence of striations near the anal region of the male claspers, by the presence of only one pair of scutellar bristles, and by the terminally curved vein R_{4+5}. Adults of this genus, especially those of *thurmanae* Foote, superficially resemble those of *Aciurina* Curran, but the presence of a large, prominent bulla in cell R_5 leaves no doubt about their proper affinities.

Key to the North American Species of the Genus Valentibulla

1—Dark areas in cells 2nd M_2 and Cu_1 wider than the hyaline marks in those cells ..... *thurmanae* Foote, new species

—Dark areas in cells 2nd M_2 and Cu_1 narrower than the hyaline marks in those cells 2

2—All pleural sclerites and at least the posterior half of disc of mesonotum shining dark brown; hyaline spot at margin of cell R_5 occupying about one-third of that cell ..... *munda* (Coquillett)

—All pleural sclerites and entire disc of mesonotum heavily gray pollinose; hyaline spot at margin of cell R_5 occupying not more than one-fourth of that cell ..... *californica* (Coquillett)

Valentibulla californica (Coquillett), new combination

(Figs. 2, 5)

Trypeta (Euaresta) californica Coquillett, 1894, Canad. Ent. 26:73 (♀, type loc., "Southern California"); Quisenberry, 1950, Jour. New York Ent. Soc. 58:10 (excludes from *Euaresta*).

Euaresta californica, Aldrich, 1905, Smiths. Inst. Misc. Coll. 46(1444):613 (repeats Coquillett data).

Euaresta mundula Coquillett, 1899, Jour. New York Ent. Soc. 7:265 (♂, type loc., Pareah, Utah); Aldrich, 1905, Smiths. Inst. Misc. Coll. 46(1444):613 (repeats Coquillett data); Quisenberry, 1950, Jour. New York Ent. Soc. 58:10 (excludes from *Euaresta*). (New Synonymy).

Head (Fig. 2).—Front white to yellow, wider at vertex than width of one eye, closely set with short, stout, white bristles; two pairs lower frontoorbitals, two pairs upper frontoorbitals; face white pollinose, flat from lateral view, the oral margin not at all projecting; cheek 0.15 to 0.25 times eye height; antenna 0.5 to 0.6 times as long as face. *Thorax.*—Mesonotum densely gray pollinose, closely set with short, stout, white to yellowish-white bristles; scutellum gray pollinose on proximal third, half or two-thirds,

the remaining parts yellow, in some cases the gray covering so much of dorsal surface that the yellow is seen only from a direct posterior view; mesopleuron gray and yellow, the gray extending from ventral half to almost the entire sclerite; the yellow, when present, appearing principally on dorsal and posterior margins without a sharp line of demarcation; sternopleuron definitely dark gray pollinose in all cases. *Legs.*—Usually entirely yellow, occasionally with a narrow dark brown streak ventrally on proximal half of hind femur; all tarsomeres entirely yellow. *Wing* (Fig. 5).—Dark reddish brown except for hyaline spots as follows: three in costal cell; subcostal cell often entirely dark, more commonly with at least the suggestion of a hyaline spot at base, sometimes this spot very large and filling basal third of cell; cell R_1 with three spots extending from the costa to vein R_{2+3}, rarely the third spot in the row extremely small to absent; cell R_3 usually with a continuation of the middle hyaline spot over vein R_{2+3}, rarely with a small, round spot below the distal spot in cell R_3; two spots in cell R_3 between the terminations of veins R_{2+3} and R_{4+5}, the distal one crossing vein R_{4+5}; a large spot in the distal end of cell R_5; three spots in second cell M_2, the distal one crossing vein M_{1+2} into cell R_5; a very large, distinct bulla in cell R_5; a large spot near center of cell R located directly posterior to subcostal cell but absent in one specimen; a large spot near distal end of first cell M_2 halfway between crossveins r-m and m-cu; three large spots in the distal two-thirds of cell Cu_1, the proximal one often crossing over vein Cu_2 + 2nd A and fusing with distal light spot in second anal cell, leaving a brown spot at the termination of that vein in the wing margin, occasionally these spots separated by a dark area of varying width along the vein; two to four light spots in second anal cell, varying from small and well separated to quite large and narrowly separated, or one or more obviously fused. *Abdomen.*—Shining dark brown to black. External male terminalia as in generic description. Female ovipositor sheath shining, constricted on apical third, about as long as the two preceding abdominal tergites.

Specimens examined.—Holotype female, *Trypeta (Euaresta) californica* Coquillett, with the following labels: "Los Angeles Co., Cal.", "May", "Coquillett collector", "Type No. 309, USNM", and "Trypeta californica Coq., type". Holotype male, *Euaresta mundula* Coquillett, with the following labels: "2426", "Type No. 4408, USNM", Pareah, Utah". CALIFORNIA: Kern Co.: 3♂♂, 3♀♀, Frazier Pk., 1♂, 2♀♀, Rosamond, 3♂♂, 1♀ Tehachapi (all IV.25.56, *Chrysothamnus nauseosum*, F. L. Blanc); 1♀ Cuyama Valley, IV.8.32, E. P. Van Duzee; Los Angeles Co.: 2♂♂, 2♀♀, Gorman, IV.25.56, *Chrysothamnus nauseosum*, F. L. Blanc; Mono Co.: Mammoth, IV.12.49, *Chrysothamnus* gall, D. D. Pierce; San Bernardino Co.: 1♂, 2♀♀, Barton Flats, San Bernardino Mts., VI.14.54, *Chrysothamnus nauseosum*, Timberlake; 1♂, 2♀♀, Oro Grande Wash, 4 mi. S. Adelanto, V.9.49, *Chrysothamnus nauseosum*, Timberlake; 1♀, Seven Oaks, VI.12.36, W. C. Reeves; 1♀, Seven Oaks, VI.14.50, Timberlake; Siskiyou Co.: 2♂♂, 1♀, Montague, V.20.36, *Artemisia* sp., Jones & Fosan; County unknown: 1♂, 2♀♀, Horsethief Cr., IV.21.35, *Salix* sp., C. E. Norland.

NEVADA: 2♂♂, Kyle Canyon, Charleston Mts. 7200', Clarke Co., VI.4.41, *Chrysothamnus nauseosum*, Timberlake.

The variation found in the rather extensive California series completely closes the gap between the Coquillett types of *californica* and *mundula*, leaving no doubt in our minds that the two species are synonymous.

The hyaline wedge at the wing apex never occupies more than the apical fourth of cell R_5, and its lower margin is always well-separated from the apex of vein M_{1+2}, which is never noticeably curved backward apically. This character, together with the densely gray-dusted mesonotum and pleural sclerites, is consistently characteristic of *californica* in contrast to *munda* Coquillett (see discussion of that species). *V. thurmanae* Foote may be separated from both *californica* and *munda* by the widely separated hyaline spots along the posterior wing margin, the larger size, the distinctly reddish cast of the body, and the short, blunt bristles covering the front and mesonotum.

Valentibulla munda (Coquillett), new combination

(Figs. 3, 6)

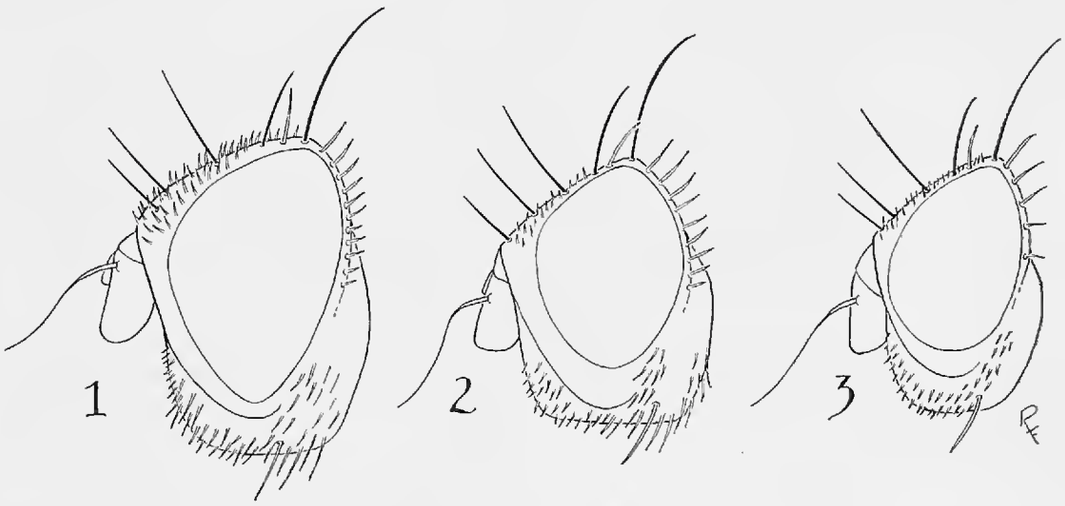
Euaresta munda Coquillett, 1899, Jour. New York Ent. Soc. 7:265 (♀, type loc. Elko, Nevada); Aldrich, 1905, Smiths. Inst. Misc. Coll. 46(1444):613 (repeats Coquillett data); Quisenberry, 1950, Jour. New York Ent. Soc. 58:10 (excludes from *Euaresta*).

Tephrella euarestoides Bates, 1935, Pan-Pac. Ent. 11:106; fig. 1, p. 105 (♀, type loc. Ridgway, Colo., 7000 ft., June 23–30, 1928; lat. view of head.) (New Synonymy).

Head (Fig. 3).—Front white to yellow, almost two times as wide as one eye at vertex, covered with short, stout, yellowish-white bristles; two or three pairs lower frontoorbitals; two pairs upper frontoorbitals; face white or yellowish-white, slightly tumid, about one-half the length of face. *Thorax.*—Mesonotum with shining dark brown to nearly black ground color with an extremely light gray dusting and closely set with short, stout, yellowish-white bristles; scutellum concolorous with disc of thorax but without short bristles; mesopleuron and sternopleuron shining dark brown with a very small amount of gray dusting. *Legs.*—Entirely yellow, including coxae and tarsomeres. *Wing* (Fig. 6).—Dark reddish brown to brown except for hyaline spots as follows: two in costal cell; subcostal cell entirely dark or with a suggestion of a hyaline spot at base, in one or two specimens distinct and filling basal fourth of cell; cell R_1 with three spots extending from costa to vein R_{2+3}, rarely the apical spot small to absent; cell R_3 in all specimens with a continuation of the middle hyaline spot over vein R_{2+3}; two spots in margin of cell R_3, the distal one crossing vein R_{4+5}; a very large triangular spot in distal third or more of cell R_5; cell R_5 with a large, prominent bulla: three spots in 2nd cell M_2, the

distal one extending across vein M_{1+2} into cell R_5, these hyaline areas separated by infuscations distinctly narrower than the width of the hyaline areas; a large round spot near center of cell R located directly posterior to subcostal cell; a large round spot near distal end of first cell M_2 halfway between crossveins r-m and m-cu; three in distal two-thirds of cell Cu_1, the proximal one always separated from distal in cell 2nd A by a dark area extending the entire length of vein Cu_2+2nd A; two to four light spots of varying sizes in cell 2nd A, rarely fused. *Abdomen.*—Shining brown to black. External male terminalia as in generic description. Female ovipositor sheath constricted on apical third, about as long as last two abdominal tergites.

Specimens examined.—Holotype male, *Euaresta munda* Coquillett with the following labels: "Elko" and "Type No. 4407, USNM". Holotype female, *Tephrella euarestoides* Bates, with the following labels: "Ridgway, Colo., alt. 7000′, June 23–30, 1928", "Type", and "*Tephrella euarestoides* Bates, holotype". IDAHO: 3♂♂, 3♀♀, Almo, Cassia Co., VI.12–13.53, H. E. Cott; 1♀, Oreana, Owyee Co., III.16.33, from galls on *Chrysothamnus;* 5♂♂, 1♀, Wieser, Washington Co., IV.26.09.



EXPLANATION OF FIGURES

Fig. 1, Lateral view of head of *Valentibulla thurmanae* Foote; fig. 2, Same, *V. californica* (Coquillett); fig. 3, Same, *V. munda* (Coquillett).

Along the margin of the wing of *munda,* the distance between the terminations of veins R_{2+3} and R_{4+5} is only slightly greater than the distance between those of veins R_{4+5} and M_{1+2}, due in part to the fact that vein M_{1+2} bends posteriorly at its apex. The resulting space is almost completely filled by a hyaline wedge that occupies at least the apical third of cell R_5 and almost touches veins R_{4+5} and M_{1+2} at the wing margin. This character is in distinct contrast to that of *californica* Coquillett, in which the spot is much smaller (see discussion of that species). This character, together with the shining brown to black thorax, will serve to separate *munda* from the other species treated herein.

Differences from *thurmanae* Foote are treated in the discussion of that species.

Bates (1934) himself recognized the doubtful position of his *euarestoides* in *Aciurina (=Tephrella)*. But for the smaller light spots near the margin of its cell 2nd A, the holotype of *euarestoides* in the Museum of Comparative Zoology does not differ markedly from that of *munda*.

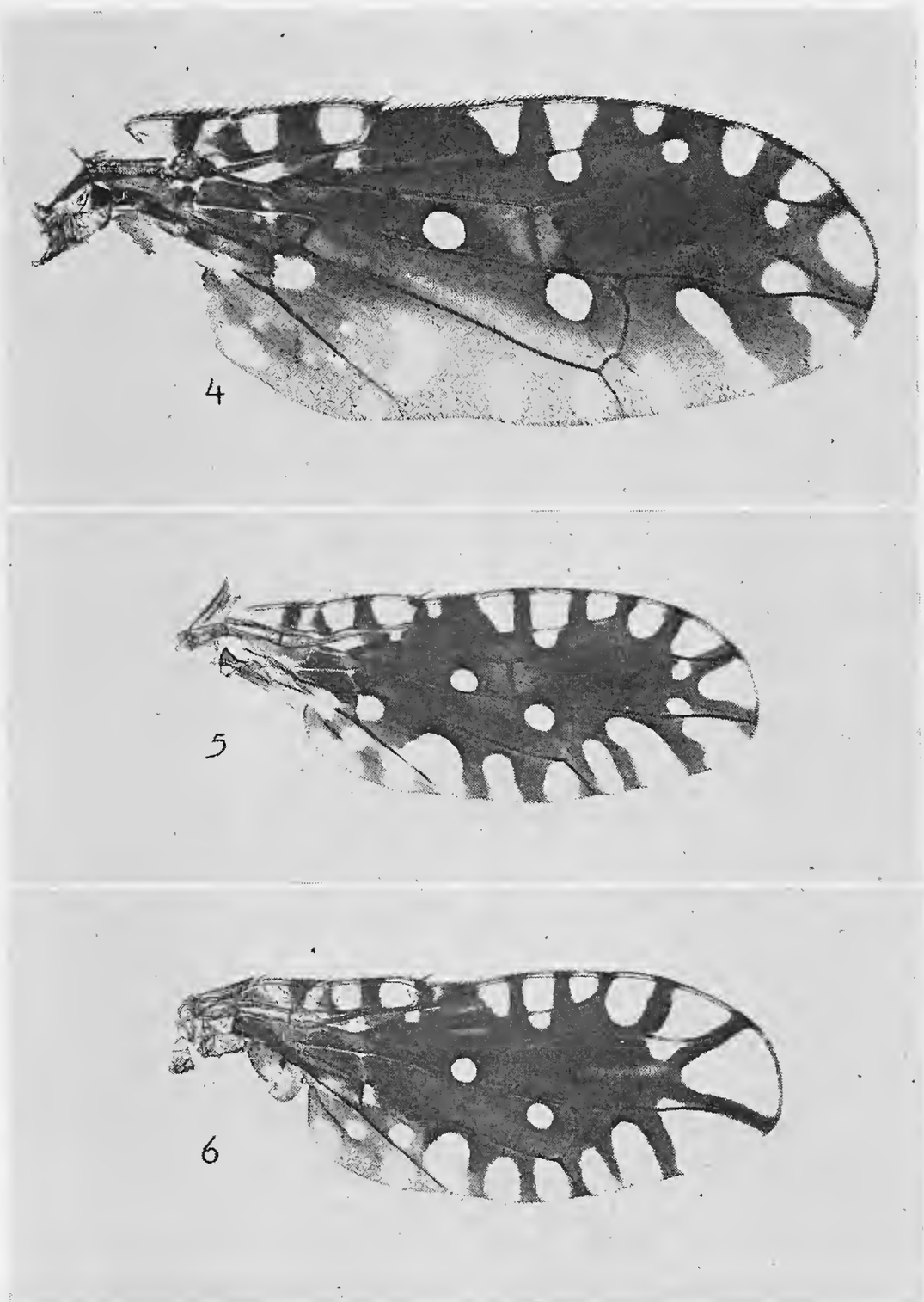
Valentibulla thurmanae Foote, new species

(Figs. 1, 4)

Head (Fig. 1).—Front distinctly yellow, almost two times the width of one eye at vertex, closely set with abundant yellowish bristles; two or three pairs lower frontoorbitals; two pairs upper frontoorbitals; face whitish-yellow pollinose, slightly tumid from lateral view; cheek 0.25 times as high as eye; antenna slightly over one-half the length of face. *Thorax.*—Mesonotum densely gray pollinose, closely set with stout, blunt bristles of a definite reddish-yellow color; scutellum with a median triangle of gray pollinosity similar to that of thorax, sides subshining, reddish; postscutellum and metathorax subshining black with reddish tinge; mesopleuron reddish pollinose; sternopleuron gray pollinose in contrast. *Legs.*—Entirely yellow, including coxae and tarsomeres. *Wing* (Fig. 4).—Reddish brown except for hyaline spots as follows: three in costal cell; subcostal cell entirely dark; three in cell R_1, the proximal two extending from costa to vein R_{2+3}, the distal spot either small and not attaining that vein or large and exceeding it; cell R_3 always with a continuation of the middle hyaline spot over vein R_{2+3} and almost always with a small round spot below the distal spot in cell R_1, sometimes these two spots fused; two marginal spots in cell R_3, the distal one crossing vein R_{4+5}; a spot in the margin of cell R_5 extending into the cell only a very short distance; cell R_5 with a large, distinct bulla; three spots in 2nd cell M_2, the distal one crossing vein M_{1+2} into cell R_5, the hyaline areas in 2nd cell M_2 separated by distances greater than their respective widths; a large round spot near center of cell R located directly posterior to tip of subcostal cell; a large round spot just distad of r-m crossvein in 1st cell M_2; three spots in distal two-thirds of cell Cu_1, the proximal one always distinct and never fusing with distal light spot in cell 2nd A, across the tip of vein Cu_2 + 2nd A; cell 2nd A mostly brown with two to four small hyaline spots as shown. *Abdomen.*—Shining brown to black. External male terminalia as in generic description. Female ovipositor sheath constricted on apical third, about 2.5 times as long as the two preceding abdominal tergites.

Holotype female, Mt. Tamalpais, Marin County, California, VI.23.18, E. P. Van Duzee (in collection of California Academy of Sciences). Paratypes: 1♀, same data as type; 1♂, 1♀ *in copulo,* Mt. View, Santa Clara County, California, "Ehrhorn Lot" (no further data); 1♀ without data of any kind.

The most obvious wing character distinguishing *thurmanae* from the two preceding species is the fact that the hyaline spots along the posterior margin are separated by distances greater than the widths of the spots themselves. Further, the light brown



EXPLANATION OF FIGURES

Fig. 4. Dorsal view of right wing of *Valentibulla thurmanae* Foote; fig. 5, Same, *V. californica* (Coquillett); fig. 6, Same, *V. munda* (Coquillett).

area in the posterior third of the wing disc of *thurmanae* contrasts markedly to the dark brown of the anterior two-thirds. Like *californica* Coquillett and unlike *munda* Coquillett, the hyaline apical spot is restricted to the apical 5th or 6th of cell R_5 and is well separated from veins R_{4+5} and M_{1+2} at the margin, but unlike both those species, is larger and redder and cell 2nd A is always more extensively infuscated. The short, stout bristles covering the front and mesonotum of *thurmanae* have a distinctly red cast in contrast to the yellow to white found in those of the other two species.

The species is named in honor of Ernestine B. Thurman.

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A NEW HOST RECORD FOR ARCHYTAS CALIFORNIAE (WALKER) IN CALIFORNIA

(Diptera: Tachinidae)

A small number of larvae of *Euchaetias oregonensis* (Stretch) (Lepidoptera: Arctiidae) (Det. H. H. Keifer) were collected on *Apocynum cannabinum* L. in the Sacramento, California vicinity by H. H. Keifer on July 7, 1950 for rearing. On August 8, 1950 a male specimen of *Archytas californiae* (Walker) emerged from one of the *Euchaetias* pupae. The larva of the *Archytas* was found to have pupated within the pupal case of its host in such a manner that its posterior spiracles were directed caudally within the pupa of the *Euchaetias*. The *Archytas* adult emerged through the anterior end of its host pupa. *Archytas californiae* appears to be generally distributed throughout the Pacific Coast states. It occurs in at least four life zones of California, since I possess specimens from localities representing the Lower Sonoran to the Canadian life zones.—Paul H. Arnaud, Jr., *California Department of Agriculture, Sacramento.*

NEW NEARCTIC TACHINIDAE[1]

(Diptera)

H. J. REINHARD

College Station, Texas

The new species described below include some interesting additions to the California muscoid fauna. I am indebted to various collectors, *viz.*, Dr. Paul D. Hurd, Jr., A. T. McClay and Paul H. Arnaud for the privilege of studying extensive lots of materials submitted over the past several years. The present report is based in part upon this material.

Viviania arrisor Reinhard, new species

Allied to *lachnosternae* Townsend, but the third antennal segment including arista and cheek grooves wholly black.

Male.—Head black in ground color with dense gray to plumbeous pollen; front at vertex 0.21 of head width, equibroad to middle thence widening rapidly into facial angle; frontalia black, a little wider than parafrontal; outer verticals vestigial, three or four frontals below antennal base and two or three suberect preverticals; ocellars long, proclinate; parafrontal with a vestiture of black hairs which extend sparsely downward almost to mid face level; facialia coarsely irregularly bristled on lower third or less, vibrissae far above oral margin; proboscis short, palpus yellow, subequal to length of haustellum; antenna rather slender, third segment slightly over twice length of second and barely reaching lower third of face; long bare arista moderately thickened near base, thence slender to tip, basal segments short; eye bare, extending below vibrissal level; cheek one-third eye-length, clothed with black hairs; occiput flat and pale-haired. *Thorax* and scutellum black, gray pollinose, mesonotum marked with four broad dark vittae in front and five behind suture; dorsocentral 3, 4; acrostichal 2 or 3, 3; presutural 2; intraalar 3; supraalar 3; sternopleural 2, 1; pteropleural 1 (small); scutellum with 4 lateral, 1 weak non-decussate apical and 1 discal pair; prosternum with bristly hairs at sides; postnotal slope setose. Legs black, mid tibia with two stoutish anterodorsal bristles, claws and pulvilli elongate. Wing gray hyaline, costal spine small; hind cross vein about its length from cubitulus; first posterior cell open considerably before wing tip; third vein with two or three setae near base; calypters semitransparent white. *Abdomen* black sometimes with a trace of red at sides, entire upper surface dusted with changeable gray pollen showing a brownish tinge in a flat rear angle; one pair of median marginals on segments one and two, a marginal row on three and four, latter also with discals above except near basal margin; genital forceps triangular in rear view with prongs contiguous to tip; accessory process fingerlike, a trifle shorter than forceps but broader than same in profile;

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[1] Contribution No. 2967, Department of Entomology, Texas Agricultural Experiment Station.

penis shiny black, recurved near middle and terminating in a pale membrane which is prolonged at the posterior apical extremity.

Female.—Vertex 0.26 of head width; two pairs of proclinate orbital bristles, outer verticals short but differentiated; median marginals usually absent on first abdominal segment and anal truncate at apex; pulvilli and claws shorter than last tarsal segment.

Length, 9.5–11 mm.

Holotype male and allotype female, TOPAZ LAKE, MONO COUNTY, CALIFORNIA, June 26, 1957 (J. W. MacSwain) in the California Academy of Sciences Collection. Paratypes: one male and two females, same data as holotype.

Viviania pedita Reinhard, new species

As described for the preceding species, but differing in the following characters among others:

Male only.—Head pollen yellowish gray, cheek grooves and vibrissal angles pale or reddish in ground color; vertex 0.18 of head width; antenna shorter or about three-fifths facial length, basal segments red; arista micro pubescent, brownish; fourth abdominal segment wholly red and contrasting sharply with preceding ones; mid tibia with one submedian anterodorsal bristle. Length, 10 mm.

Holotype male, LAKE PLACID, FLORIDA, March 3, 1945 (J. G. Needham).

Phorocera regilla Reinhard, new species

A small species, which traces to *festinans* in Aldrich and Webber's key (Proc. U. S. N. M., 63:45–48), but by comparison with the type specimen differs in genital characters among others.

Male.—Head pollen gray with yellow tinge on parafrontals; latter sparsely beset with fine hairs and about equal to width of dark brown frontalia; two pre-verticals, ocellars and inner verticals about equal in size; frontals weak, three bristles below antennal base; vertex 0.25 of head width; narrow parafacial equal to facialia inverted; latter bristled to upper third or higher and usually with a secondary outer row of hairs; antenna entirely black, as long as face, third segment much broader than parafacial, six times longer than second; black, bare arista thickened on proximal two-fifths thence suddenly tapered outward to a thin or very delicate tip; cheek hardly one-sixth eye length; eye pilose; proboscis short, palpus brown to reddish apically. *Thorax* and scutellum black, lightly dusted with grayish pollen leaving rather narrow poorly defined vittae on notum. Chaetotaxy: acrostichal 2, 3; dorsocentral 3, 4; intraalar 3; supraalar 3; presutural 2; posthumeral 2; humeral 2; sternopleural 3; pteropleural 1 (small); scutellum with 3 lateral, no apical, 1 poorly differentiated discal pair. Legs black, weakly bristled; hind tibia not evenly ciliated; mid tibia with one median bristle on outer front side; claws and pulvilli exceeding length of apical tarsal segment. Wing slightly smoky becoming grayish on hind margin; third vein with two or three setulae near base;

first posterior cell open shortly before wing tip; hind cross vein oblique and its length from the broadly rounded stumpless cubitulus; costal spine small; calypters transparent tawny. *Abdomen* black, pointed apically, last three segments with pale yellowish gray pollen which extends thinly rearward to or beyond middle of each except along median line; one pair of median marginal bristles on second segment, a marginal row on the two following ones, besides a discal row on anal and a discal pair on each intermediate segment; genitalia black; forceps tapered on basal third, thence subparallel to a blunt or rounded apex, prongs divided on apical half but not divergent; accessory process longer than forceps, ovate and wide in profile but reduced to a subacute apex and concave on outer face; penis shining black basally, with intermediate anterior portion pale membranous, distal part black, compressed and beset with a vestiture of appressed whitish scales.

Female.—Vertex 0.28 (average of three) of head width; abdomen broader and usually with grayer pollen than in male; two proclinate orbitals; outer verticals differentiated; wing nearly clear; claws and pulvilli small.

Length, 3–4 mm.

Holotype male, REDWOOD CITY, SAN MATEO COUNTY, CALIFORNIA, July 27, 1952 (P. H. Arnaud) and allotype female, Mountain Home, San Bernardino County, California, September 12, 1953 (E. I. Schlinger) in the California Academy of Sciences Collection. Paratypes: 14 males, 2 females same data as holotype; 1 male and 2 females, Chiricahua Mts., Ariz., July 8, 1932 and July 4, 1940 (R. H. Beamer); 1 male and 1 female, Graham Mountains, Arizona, 6000–7000 feet, August 9, 1955 (Butler-Noon).

Phorocera ustulata Reinhard, new species

Differs from the preceding species chiefly as follows:

Male.—Parafacial seal brown, pollen becoming thinner and lusterless on parafrontal, latter blackish in most views and hardly equal width of dark brown frontalia; cheek nearly one-third eye length, dusted with gray pollen which extends over entire hind surface of head; vertex 0.33 of head width; third antennal segment subequal to parafacial width; five times length of second; arista thickened on proximal half; facialia narrower and subvertical, with a single row of bristles extending above middle; palpus red to brownish basally; eye with moderately long pale dense hairs; scutellum reddish apically and usually with a well differentiated pair of erect discals. *Abdomen* obovate, last three segments dusted with gray or yellowish gray pollen which extends thinly to hind margin of each in favorable view; one pair of median marginals on segments one and two, a marginal row on three and four besides a row of discals often irregularly spaced on last; intermediate segments with one pair of discals and a vestiture of longish hairs including some bristlelike and erect along median line; genital forceps small, shiny black, tapering gradually with prongs

contiguous to subacute apex; accessory process in profile about as thick as forceps but a trifle longer and tapering to an equally narrow apex which bears a few minute spinose hairs; basal stalk of penis quite slender, distal segment ovate, black with a pale semitransparent area along hind margin.

Female.—Vertex 0.34 (average of four) of head width; notal pollen heavier and vittae more distinct than in male; third antennal segment three and one-half to four times second; facialia bristled about to middle; abdomen broadly ovate, with moderately dense gray or yellowish gray pollen on last three segments; claws and pulvilli small.

Length, 4–6 mm.

Holotype male and allotype female, REDWOOD CITY, CALIFORNIA, February 8 and 9, 1953 (P. H. Arnaud) in Paul H. Arnaud's Collection. Paratypes: 43 males and 1 female, same data as type except in part dated February 1953, on foliage of *Quercus agrifolia*; 6 females, Kings Mountain Road, Woodside, San Mateo County, California, April 17, 1956 (P. H. Arnaud); 198 males and 86 females, Stanford University, Santa Clara County, California, February–April 1952–1958 (P. H. Arnaud); 3 males, Ithaca, N.Y., July 11 and 24, 1935 (K. V. Krombein); 1 male, Babylon, L. I., N. Y., July 13, 1933 (F. S. Blanton); 2 males and 1 female, Bear Mountain State Park, Bear Mountain, N. Y., April 28, 1936 (L. L. Pechuman); and 1 male, Greenwood Lake, N. J., May 1, 1918 (Wm. T. Davis); 1 male, Torrey, Utah, May 9, 1941 (G. F. Knowlton, F. C. Harmston).

Phorocera anassa Reinhard, new species

Aside from its larger build the present species differs from *P. regilla* Reinhard chiefly as follows:

Male.—Parafacial and parafrontal pale yellowish gray pollinose, cheek and occiput cinereous; vertex 0.27 of head width; frontalia narrower than parafrontal; latter with numerous erect black hairs extending from upper extremity to lowermost frontals near aristal level; bare parafacial about equal to width of third antennal segment, which is fully five times longer than second; arista thickened on proximal half; facialia with a single row of bristles ascending well above middle; cheek nearly one-fourth eye length; palpus brownish yellow paler before tip; scutellum reddish apically, with a pair of non-decussate apical bristles set slightly higher up and in front of hindmost lateral and one pair of erect discals far behind middle; hind cross vein a trifle less than its length from cubitulus; calypters pale yellow; last three abdominal segments with gray pollen, which extends thinly to hind margin of each, hairs on entire upper surface erect longish and somewhat bristly along median line; genital forceps slender, prongs contiguous, gradually tapered from base to tip and very thin in profile; accessory process shorter and much broader than forceps; penis entirely black, distal segment glabrous, bowed rearward and tubular in cross

section but tapering slightly towards tip.

Female.—Thorax and abdomen with much denser pollen, otherwise similar to male except for the usual sexual diffeernces.

Length, 7 mm.

Holotype male and allotype female, LAKE WAHA, IDAHO, August 8, 1941, no collector's label.

Aphantorhapha hurdi Reinhard, new species

A minute black fly, dusted with opaque cinerous pollen; legs more or less reddish; hind cross vein strongly retracted, etc.

Male.—Head pollen whitish on pale background; front nearly one-half head width, inner orbits parallel from vertex to cheeks; frontalia pale yellowish fully twice width of parafrontal, latter practically bare outside frontal row; proclinate ocellars short but distinct; two verticals and proclinate orbitals; one frontal bristle below antennal base; bare parafacial sublinear below middle; facialia bare; vibrissae short, on oral margin; antenna red basally, third segment largely blackish and about four times second; arista barely exceeding length of third antennal segment, thickened to pointed tip, basal segments elongated and each subequal one-half length of apical segment; proboscis short, palpus yellow; cheek bare, one-third eye length; back of head flat and practically bare. *Thorax* and scutellum with rather dense gray pollen, notum not vittate, transverse suture obsolete; acrostichal 2, 3; dorsocentral 2, 3; presutural 2; sternopleural 3 (lowermost hairlike); scutellum with extreme apex tinged with red, 3 lateral bristles and a non-decussate hairlike apical pair; propleuron and postnotal slope bare. Legs rather short and stoutish, bristling very weak; claws and pulvilli minute. Wing hyaline, reaching well beyond apex of abdomen; first posterior cell closed at costa a trifle before exact wing tip; last section of fifth vein three-fourths to equal length of preceding section; third vein with three or four setulae extending half way or more to small cross vein; costal spine minute; epaulet yellow; calypters opaque white. *Abdomen* black with extreme hind edge of segments one to three contrasting pale yellow in ground color, entire upper surface dusted with gray pollen, a vague median vitta generally apparent; one pair of median marginals on second segment and a marginal row on third and fourth; genital segments small and retracted.

Female.—Very similar to male; genitalia retracted within anal orifice. not adapted for piercing.

Length, 2.25–2.75 mm.

Holotype male and allotype female, SURPRISE CANYON, PANAMINT MOUNTAINS, INYO COUNTY, CALIFORNIA, April 24, 1957 (P. D. Hurd, Jr., G. I. Stage) in the California Academy of Sciences Collection. Paratypes: one pair, same data as holotype.

Homalactia facula Reinhard, new species

Differs from *H. harringtoni* (Coquillett) mainly in having the legs, abdomen and antennae mostly pale reddish in ground color.

Female only.—Head thinly gray pollinose; vertex 0.32 of head width; decussate inner and erect outer verticals nearly equal in size; ocellars small or hairlike; one proclinate and two reclinate orbitals; frontals in a single row descending almost to aristal level; frontalia pale yellow, wider than one parafrontal; entire face including cheeks pale in ground color; facialia with a few bristly hairs next to vibrissae, which are situated on level with oral margin; parafacial very narrow and bare; antenna largely reddish, third segment slightly darker on outer side beyond middle, about two and one-half times longer than second; bare arista rather short, thickened on basal three-fifths or more; proboscis short; palpi yellow; cheek nearly two-fifths eye length. *Thorax* black lightly sprinkled with grayish pollen; three post dorso-centrals and three sternopleurals; pteropleural nearly as strong as intermediate supraalar; scutellum yellowish apically, bearing three lateral bristles and a decussate apical pair. Wing subhyaline with small and hind cross veins infuscated, apex of first vein and base of third less distinctly so; first, third and fifth vein setose; first posterior cell open shortly before extreme wing tip; epaulet yellow; calypters tawny. Legs except tarsi yellow; middle tibia with two median anterolateral bristles; claws and pulvilli short; fore tarsi moderately flattened and stoutish. *Abdomen* reddish yellow basally, hind margin of intermediate segments infuscated, fourth wholly black and each gray pollinose on narrow basal edge; second segment with one pair of median marginal bristles, a marginal row on the two following ones besides a discal row on the last and one pair of discals on segments two and three.

Length, 4 mm.

Holotype female, RIVERSIDE, CALIFORNIA, July 15, 1955 (J. C. Hall), in the California Academy of Sciences Collection.

Siphonopsis conata Reinhard, new species

A small species with a reddish yellow abdomen usually infuscated along median line; male third antennal segment uncommonly large; slender labella folded back on haustellum, etc.

Male only.—Front and face wide, approximating one-half head width, dusted with grayish yellow pollen on pale ground color; uppermost prevertical small, preceding one stoutish or equal size of outer vertical; two or three frontal bristles beneath antennal base with a few minute setae extending below latter; frontalia pale reddish to yellow, nearly three times parafrontal width; antenna subequal length of face, short proximal segments red, third black, strongly widened to a subtruncate or broadly rounded apex; arista reddish, thickened on proximal two-fifths, second segment a little under one-half length of third and basal segment short; parafacial narrow; facialia with a few setae next to vibrissae which are on oral margin; haustellum slender but barely one-half head height; palpus yellow; cheek slightly under one-third eye length; eye bare. *Thorax* black, humeri, pleura and apex of scutellum more or less reddish, notum with dense gray patternless pollen, transverse suture evanescent; prosternum sparsely setose; three post dorsocentrals and sternopleurals; scutellum with three lateral,

one hairlike decussate upturned apical and one appressed discal pair. Legs yellow, tarsi black, claws and pulvilli minute. Wing clear with a yellowish tinge; costal spine vestigial; third vein setulose halfway or more to small cross vein; first posterior cell narrowly open at wing tip; hind cross vein about mid way between small cross vein and cubitulus; latter broadly rounded without fold or stump; last section of fifth vein one-third length of preceding section; epaulet yellow; calypters transparent tawny. *Abdomen* narrower than thorax, tapered toward tip; hairs on entire upper surface appressed; one pair of median marginals on second segment, a marginal row on last two; genitalia yellow, caudoventral; forceps rather short, triangular on basal half in rear view, thence compressed and very slender to apex; accessory process a trifle longer than forceps, slender beyond middle and moderately constricted before rounded apex.

Length, 4.5 mm.

Holotype male, MILL VALLEY, MARIN COUNTY, CALIFORNIA, May 30, 1926 (E. P. Van Duzee) "Ex: *Phryganidia pupae*," in the California Academy of Sciences Collection. Paratypes: seven males, same data as holotype.

A CHALKBOARD TECHNIQUE FOR MAKING ILLUSTRATIONS

E. P. CATTS AND J. H. YOUNG
University of California, Berkeley

In making certain illustrations of internal acarine morphology, a chalkboard technique was developed which has proved to be highly satisfactory. This method is economical, requires simple dark room equipment, is time saving, tends to diminish small drawing errors and gives both 35 mm. slides as well as negatives for making prints.

Illustrations were drawn with white chalk on a 4 x 6 foot portable blackboard. All permanent white marks and scratches on the blackboard were covered with india ink. The drawings were made as large as the board permitted. The fingernail of the artist was used to make the rough outline on the blackboard. Illustrations were outlined with white chalk and stippled and highlighted with both white and black chalks. Freehand lettering was employed although other methods, such as precut labels, could have been substituted.

The finished drawing was photographed with a 35 mm. camera (Leica, 50 mm., 3.5) mounted on a tripod at a distance of approximately 12 feet. Camera "f" setting was 3.5, shutter speed from .25 to 1.0 second, using Kodak microfile film. The

time of exposure varied with available light. The light sources were overhead fluorescent lights supplementing daylight from a ceiling skylight.

The film was developed in Kodak microdol developer and, after washing and drying, was used to make a second film exposure on positive film. This second negative was made by pressing a small piece of positive film over the microfile negative and exposing it for .5 of a second to a 15 watt light at 10.5 inches on a contact printer. The positive film was developed in D11 developer and was used to make the finished print for publication. The final result is shown in Figure 1. Prints made from this second negative produce black lines on a white background or the reverse of the original chalkboard illustration.

Use of a light meter would simplify obtaining the correct exposure, although taking each drawing at three different exposure times (.25, .50, 1.0 second) produced at least one satisfactory negative. Opaque film paint was useful for retouching the negative.

The microfile negative can be mounted for screen projection in illustrating lectures. Series of graphs could be prepared by first painting coordinates on the board with white paint and then plotting curves in chalk. An opaque projector, such as a balopticon, will be useful for roughing-in complex figures. The use of sharpened chalk sticks permit drawing of very fine lines.

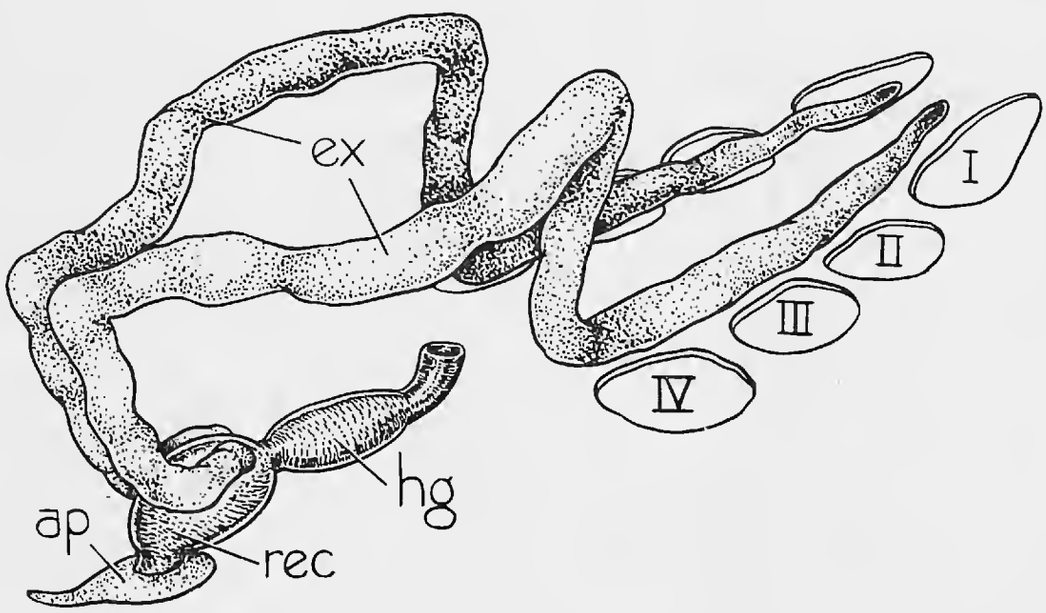

Fig. 1. The excretory tubules in a mite; a drawing prepared using the chalkboard technique.

TWO NEW NORTH AMERICAN SPECIES OF ANELAPHUS LINSLEY

(Coleoptera: Cerambycidae)

JOHN A. CHEMSAK[1]

University of California, Berkeley

The genus *Anelaphus* was proposed by Linsley (1936) to include certain species which had been referred to *Anoplium* or *Elaphidion*. As currently defined, the genus consists of 13 species including the two described below.

Anelaphus inflaticollis Chemsak, new species

Female. Form elongate; integument piceous to rufo-piceous; pubescence yellowish or tawny. *Head* coarsely punctate with a slightly raised impunctate area between eyes, a longitudinal sulcus extending the length of face from impunctate area on vertex to clypeus; pubescence yellowish, appressed, occurring in patches on vertex, antennal tubercles, and front; antennae shorter than body, segments three to five spined at apices, segments four to eleven excavated, obtusely carinate above, third segment subequal to scape in length, fourth shortest, fifth to seventh subequal, shorter than third, eighth to tenth gradually decreasing in length, tenth subequal to fourth, eleventh subequal to fifth. *Pronotum* inflated, sides broadly rounded, equal to elytra in width; pubescence dense, pale, rather fine and appressed, nearly obscuring surface; punctures dense, rather fine; disk with a long, narrow, glabrous, slightly raised vitta reaching almost to apex of pronotum, basally joined by two punctuate arcuate vittae on either side, assuming a W-shape, prosternum not impressed in front of coxae, coarsely, contiguously punctured, finely, moderately pubescent, anterior edge glabrous, transversley, irregularly wrinkled, meso- and metasternum finely punctate with occasional coarse punctures interspersed, finely pubescent, more densely at sides; episternum of metathorax very sparsely, coarsely punctate. *Elytra* about 2.7 times longer than broad; surface sparsely, coarsely, punctate, much more shallowly toward apices, punctures widely separated; pubescence rather densely irrorate with depressed whitish hairs, suberect hairs about same length as depressed; apices subtruncate, sutural angle not dentiform. *Legs* rather short, femora moderately coarsely, shallowly punctate, moderately pubescent. *Abdomen* finely punctate, moderately pubescent; fifth sternite broadly rounded, very slightly emarginate at apex. Length 13 mm.

Holotype female: APPLE VALLEY, SAN BERNARDINO COUNTY, CALIFORNIA, May 24, 1955 (D. F. Hardwick), in the Canadian National Collection, Ottawa, Ontario.

This species is allied to *A. brevidens* (Schaeffer) from which it may be readily differentiated by the inflated appearance of

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[1] The writer is indebted to Henry F. Howden and E. G. Linsley for the opportunity of describing these species, and to the latter also for the use of his manuscript key to the species of *Anelaphus*.

the pronotum, the finer pronotal punctation, and the less dense elytral punctation.

Anelaphus antennatus Chemsak, new species

Male. Form elongate, robust; integument light reddish brown; pubescence sparse, pale; antennae twelve segmented. *Head* finely, confluently punctured on vertex, coarsely, confluently between eyes, a narrow ill-defined linear smooth area between eyes joining with frontal sulcus; pubescence sparse, fine, suberect, small tufts of depressed yellowish hairs on antennal tubercles and on vertex; antennae longer than the body, twelve segmented, segments three to eight spined at apices, spines decreasing in length from the third, segments beginning with fourth excavated dorsally, obtusely carinate; scape longer than the third segment, fourth shorter than third, fifth to ninth subequal to scape, tenth and eleventh shorter than scape but longer than third, twelfth shortest except for second; antennal punctation fine, dense, pubescence fine and moderate. *Pronotum* wider than long, broadly rounded at sides, pubescence short, suberect, denser at sides, basal margin with small linear patch of depressed hairs at middle; punctures moderate, confluent, middle of disk with small glabrous callus; prosternum scarcely impressed in front of coxae, moderately, densely, confluently punctate except for anterior band which is shining and transversely wrinkled, pubescence short, sparse; meso- and metasternum sparsely, moderately punctate, moderately, finely pubescent. *Elytra* about 2.7 times longer than broad; surface rather finely, moderately, separately punctured, punctures becoming shallow apically; pubescence sparse, short, suberect, with small patches of whitish hairs scattered over surface; apices obliquely truncate, sutural angles slightly dentiform. *Legs* long, robust, finely, densely punctate, moderately densely pubescent. *Abdomen* finely, sparsely punctate, finely pubescent; fifth sternite broadly truncate. Length, 18 mm.

Holotype male: FORT DAVIS, JEFF DAVIS COUNTY, TEXAS, August 1-15, 1927, deposited in the California Academy of Sciences, San Francisco.

This species exhibits some affinity with *A. subinermis* Linsley and *A. inermis* (Newman). It differs from these by having 12 segmented antennae, at least in the male, and spines at the apices of six antennal segments. The first character will also separate *antennatus* from all of the other described species in the genus.

The holotype has three segments missing from one of the antennae and is also a little rubbed. However, the appressed patches of white hairs on the elytra are evident, and fresher specimens should reveal the extent of the pubescence.

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1936. Preliminary Studies in the North American Phoracanthini and Sphaerionini. Ann. Ent. Soc. Amer., 29:464.

ANOPLODERA LAETIFICA (LECONTE) AND ERGATES SPICULATUS LECONTE FROM KNOB-CONE PINE

(Coleoptera: Cerambycidae)

ERNEST H. SCHOENING AND J. W. TILDEN
San Jose State College, San Jose, California

During May, 1958, the senior author found *Anoplodera laetifica* (LeConte) in knob-cone pine (*Pinus attenuata* Lemmon) in considerable numbers in a 1955 burn south of Ben Lomond in the Santa Cruz Mountains. The exact area is southerly from Ben Lomond, on the east side of the San Lorenzo Valley, and almost half way between Glen Arbor Road and the top of the hill on the right side of Quail Hollow Road. The slope is north-westerly. The only species of pine that was studied was knob-cone pine, although other pines occur at some little distance away.

All of the pines in the immediate area were killed by the fire. The tops of the dead pines have fallen over and stumps from eighteen inches to about three feet high remain. These stumps range from eight to twelve inches in diameter. From these stumps twenty adults of *Anoplodera laetifica* were collected.

The males among these specimens showed the usual dimorphism characteristic of this species. Several were all black, one was black with small red humeral markings, and others were reddish or dull brownish with various degrees of black marks. The females were the normal red with black spots.

All adults were cut from solid, relatively dry wood, and within two feet of the ground. Many larvae and pupae were also found at the same time. The larval tunnels are concentrated in the deeper parts of the wood, at a depth of more than one or two inches, and seem to run generally in a longitudinal pattern to the tree (that is, with the grain). Mature larvae turn toward the periphery of the tree and make pupal cells facing the outside, within a half inch of the surface and at right angles to the larval tunnels.

In spite of the abundance of *Anoplodera laetifica*, little has been noted concerning its food preferences and habits. The present observations indicate that it utilizes wood of dead pines and that knob-cone pine is suitable to its needs. The occurrence of *A. laetifica* in many localities where knob-cone pine does not occur, indicates that other trees also may be utilized. The junior author

suggests that since *A. laetifica* is a common species, it may be useful in reducing stumps.

Larvae of *Ergates spiculatus* LeConte were common in the downed tops of the pines as they lay on the ground, but were absent, or nearly so, from the standing stumps. The *Ergates* larvae were somewhat less than two inches in length and appeared to lack at least a year of being mature. If this estimate is correct, it suggests a lag of about four years between destruction of trees by fire, and the emergence of *Ergates* from the killed trees.

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When circumstances forced Father T. Borgmeier to cease publication of his outstanding "Revista de Entomologia" with Volume 22 in 1951, he and the publishers, Editôra Vozes, did manage to issue a new occasional series under the title "Studia Entomologica." Three numbers appeared (1952, 1953, 1955) totaling 801 pages. Now, with the help of Brazil's National Research Council, this has become a formal journal: "Studia Entomologica. Revista Internacional de Entomologia." Under the direction of Thomaz Borgmeier, O.F.M., and Walter W. Kempf, O.F.M., Volume 1, *new series*, was published in 1958 (fasc. 1–2, January 31; 304 pp.; fasc. 3–4, November 29; 278 pp.). It will continue to appear twice a year, in double fascicles of approximately 250 pages each.

The Revista's worthy successor, very similar in format, will publish articles in Latin, Portuguese, Spanish, Italian, French, English and German. Papers may be on the biology and systematics of insects in general, but emphasis is naturally on the Neotropical fauna. There is a section for short notes, including quotations of significant paragraphs from articles in other journals, and one on bibliography. Volume 1 *(n.s.)* fasc. 1–2 has two articles on Coleoptera (T. Borgmeier; A. Reichensperger), four on Diptera (D. Albuquerque; C. Colyer; J. Lane; H. Schmitz), one on Embioptera (D. Lacombe), four on Hymenoptera (T. Borgmeier; W. L. Brown; W. Glöckner; W. Kempf); fasc. 3–4 has two on Coleoptera (A. Martinez; R. Barth), six on Diptera (T. Borgmeier; M. Carrera and K. Lenko; F. Hull; J. Lane and C. d'Andretta; J. Lane and N. Cerqueira; H. Lopes), three on Hymenoptera (W. Glöckner; W. Kempf), one on Orthoptera (S. Toledo Piza) and one on Strepsiptera (M. Kogan). There are many illustrations.

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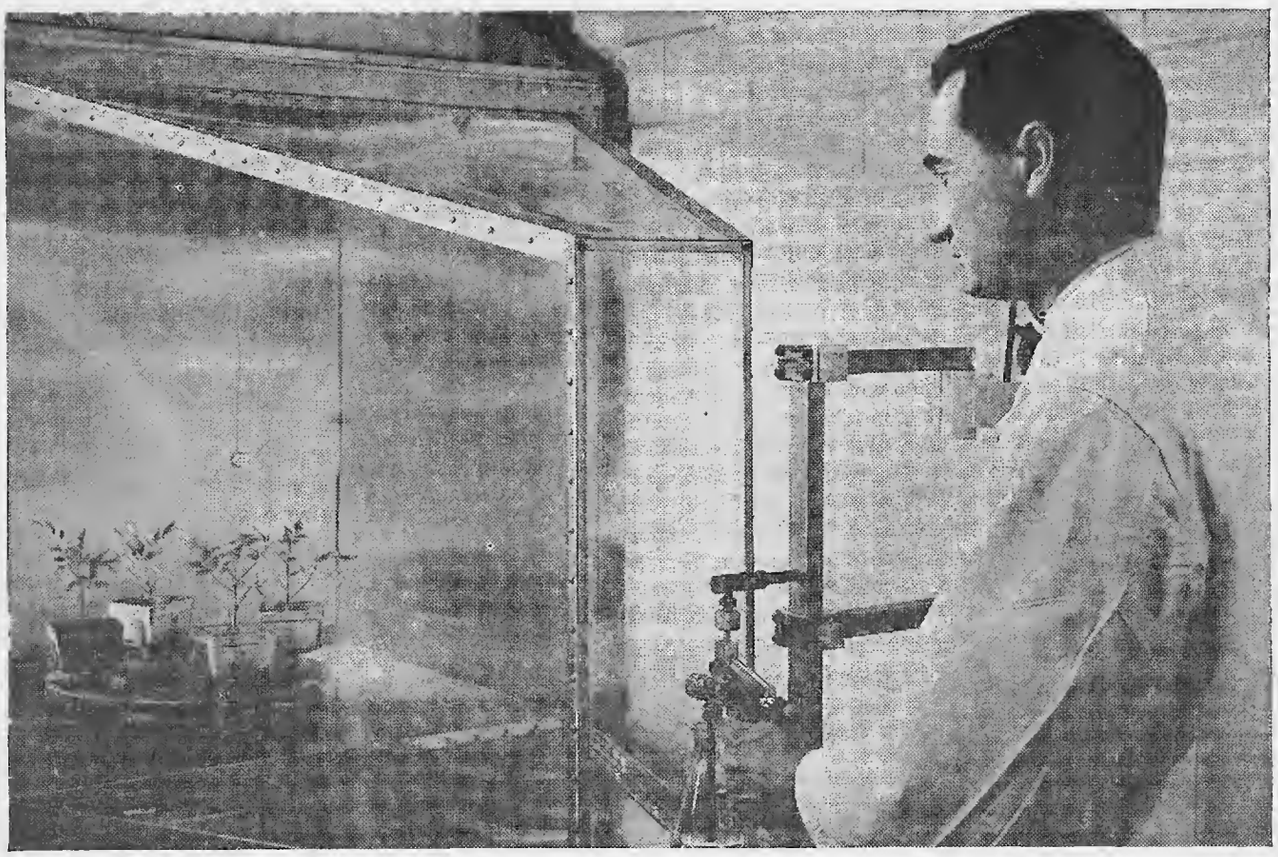

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BIOLOGY OF APHODIINAE WITH SPECIAL REFERENCE TO OREGON

(Coleoptera: Scarabaeidae)

Manohar Lal Jerath and Paul O. Ritcher

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Our knowledge of the biology of the subfamily Aphodiinae is still rather fragmentary. Such information as is now available relates only to a few of the known species (Mulsant, 1842, 1871; Xambeau, 1890; Cabanes, 1920; Madle, 1934; Hoffman, 1935; Martyn, 1956; Ritcher, 1958).

Tribe Aegialiini

Species belonging to this tribe have been described since 1787, but so far no one has reported on the biology of the group. We have collected several species under vegetation on sand dunes at the Oregon coastal beaches and also in sandy areas along inland streams.

At Waldport, Oregon, *Aegialia blanchardi* Horn was collected throughout the year from 1955 to 1957, inclusive. This species was collected by sifting sand around and beneath the roots of vegetation on the dunes. Apparently there is only one generation a year because larvae and pupae were found only during early summer from May 29 to July 16. Usually they were at a depth of approximately 6 to 8 inches below the surface. At this depth, the temperature ranges from 50° to 60° F. throughout the year. Adults were present throughout the year just below the surface.

Temperature seems to have some effect on the length of the pupal stage within the range of 60° F. to approximately 70° F.; it has considerable effect on mortality. On June 12, 1956, more than 200 third-stage larvae of *Aegialia blanchardi* Horn were collected at Waldport, Oregon. One group of 20 larvae, each in a separate salve box, was kept at room temperature. These larvae pupated in two to four days and the pupal stage lasted for 12 to 15 days, but the mortality was 60%. Another group of 20 larvae, each in a separate salve box, was kept at 60° F. These larvae pupated seven to 10 days later and the

pupal stage lasted for 15 to 19 days. The mortality in this group was only 10%.

At Kiger Island, five miles southeast of Corvallis, Oregon, on May 27, 1957, numerous second and third-stage larvae and adults of *Aegialia* spp. were collected in sand drifts under willows, by sifting the sand. (Dr. O. L. Cartwright of the U.S. National Museum identified the adults as *Aegialia blanchardi* Horn, *A. lacustris* LeConte, *A. latispina* LeConte, and *A. nigrella* Brown). Eight trips were made from May 27, 1957 to September 15, 1957, but no larvae were found on either August 15 or September 15, 1957. Pupae were found as early as June 17, and as late as August 15, 1957. Examination of the fore gut contents showed that the larvae were feeding only on decaying organic matter.

The above information indicates that the species of the genus *Aegialia* apparently have one generation a year and the adults over-winter. The adults probably lay eggs in spring, and the larval stage lasts till the third week of July. Newly transformed adults were numerous during late July and August. Examination of the ovaries of the females during August and September showed no egg development.

Tribe Aphodiini

Food Habits and Economic Importance: The members of this tribe are commonly found in dung all over the world. Species have been reported to occur in deer, cow, horse, sheep, human, elephant, rat, and other animal manure. Eight species, however, have been found to feed on live roots of plants. Four are parasitic and one feeds on decaying leaves. Two species seem to be myrmecophiles.

Lugger (1899) observed larvae of *Aphodius granarius* (Linnaeus) eating the sprouting seeds of corn in Minnesota. In Oregon, larvae of A. *granarius* have been found in the soil where they may have been feeding on grass roots. Downes (1928) in British Columbia and Ritcher and Morrison (1955) in Oregon, reported larvae of *Aphodius pardalis* LeConte feeding on golf turf and doing considerable damage.

Swan (1934) and Carne (1950) recorded *Aphodius howitti* Hope (= *A. tasmaniae* Hope) destructive to pastures in the southeast portion of Australia and Tasmania. Van Emden (1941) records larvae of *Aphodius fimetarius* (Linnaeus) being noxious on potatoes at Bremen, Germany, and larvae of *Aphodius contam-*

inatus Herbst were collected in a golf course. In England, adults of *A. fimetarius* and *Aphodius subterraneus* (Linnaeus), which are common in horse manure, have been reported to injure mushrooms by devouring portions of the caps (Anonymous, 1944).

Martyn (1956), in Tasmania, worked out the distribution in relation to climate of *Aphodius howitti* Hope and *Aphodius pseudotasmaniae* Given. According to him, the larvae of these species feed on pasture plants.

Aphodius larvae were collected injuring mint roots at Quincy, Washington, on July 27, 1955 by C. H. Starker. Adults reared from these larvae were identified by O. L. Cartwright as *Aphodius distinctus* Müller. Larvae later identified as *Aphodius hamatus* Say were found injuring the turf in pastures in Ruby Valley, Nevada, by R. W. Lauderdale.

Chapman (1870) noted *Aphodius porcus* (Fabricius) parasitizing the egg of *Geotrupes stercorarius* (Linnaeus). Howden (1955) found *Aphodius lividus* (Olivier) and *Aphodius rubeolus* Beauvois parasitizing and developing in the egg cell of *Phanaeus* and *Onthophagus medorensis* Brown. Howden is of the opinion that *Aphodius* larvae destroy and may consume the eggs or larvae of the host.

Larvae of *Aphodius* sp. were collected in a *Formica* nest at a locality eight miles east of Silver Lake, Oregon, on May 16, 1957. These larvae were found in the dry upper part of the nest, with the ants, but were not being bothered by the ants. Mann (1911) collected eight adults of *Aphodius suspectus* Mann, on bait, from a *Formica* nest at Pullman, Washington.

Adults of *Oxyomus silvestris* (Scopoli) have been recorded to occur in dung in Europe, Schmidt (1911). Larvae loaned to the writers by the U.S. National Museum were collected in the soil around roses at Luxemburg on May 24, 1949.

Length of Life Cycle: According to Madle (1934), *Aphodius fimentarius* (Linnaeus) and *Aphodius depressus* Kugel have two generations a year and *Aphodius fossor* (Linnaeus) and *Aphodius rufipes* (Linnaeus) have a single generation a year in Dresden (Germany). There, *A. fimetarius* and *A. depressus* overwinter as larvae, whereas *A. fossor* and *A. rufipes* may overwinter as larvae which pupate in spring. *A. rufipes* and *A. fossor* may overwinter as adults, if the conditions are favorable in early fall. Also, in Germany, *Aphodius alpinus* (Scopoli) over-

winters as larvae and *Aphodius prodromus* Brahm overwinters as adults.

Most members of this tribe, in Oregon, have one generation a year. According to the writers' observations, *Aphodius fimetarius* (Linnaeus), *Aphodius granarius* (Linnaeus), *Aphodius pectoralis* LeConte, *Aphodius sparsus* LeConte, and *Aphodius aleutus* (Eschscholtz) have one generation a year. *Aphodius vittatus* Say appears to have two generations a year in Oregon. *A. fimetarius*, *A. granarius* and *A. vittatus* overwinter as adults, whereas *A. sparsus* and *A. aleutus* overwinter as mature larvae.

According to van Emden (1941), the larvae of lamellicornia moult thrice, the third ecdysis releasing the pupa. The writers have also found only three instars of *Aphodius* larvae.

Tribe Eupariini

Of the tribe Eupariini, biological information is available only for *Ataenius cognatus* (LeConte), Hoffman (1935). Brief notes on the habitats for some members of this tribe are given by Cartwright (1944, 1948, and 1952) in his papers on adults.

Hoffman (1935) states that the larvae of *Ataenius cognatus* (LeConte)[1] infest golf courses in Minnesota. The adults in Minnesota overwintered, and there was one generation a year. According to him, the beetles were taken in light traps as early as May 1, but the females oviposited in late May or June. The length of pupal period in the laboratory was 8.7 days. On September 1, on digging in the golf course, no larval stages were found, but the beetles were hiding in waste piles of grass.

Adults and larvae of *Ataenius spretulus* (Haldeman) were collected and reared in cow dung by Paul O. Ritcher at Lexington, Kentucky during 1944.

Adults of *Ataenius saxatalis* Cartwright were collected in South Carolina in sand washed down to the edges of pockets or islands of soil and vegetation on outcroppings of bare weathered areas of granite or rocks, or in the sand or soil around the lower edges or such areas of rock (Cartwright, 1944).

Adults of *Ataenius fattigi* Cartwright were collected in South Carolina under leaves, twigs and surface litter along paths on hard ground in woodlands. Two adults were taken under dry

[1] According to O. L. Cartwright in a letter dated September 22, 1955, the species with which Hoffman was dealing could be *Ataenius spretulus* (Haldeman).

cow dung in a burned-over woods and a few more taken in light traps (Cartwright, 1948).

Adults and larvae of *Euparia castanea* Serville are recorded occurring in ant nests (Schmidt, 1911). According to Horn (1887), this species occurs in Florida, Alabama and Louisiana in the nests of a small ant (species not given).

Adults and larvae of *Saprosites* are found under the bark of trees (personal communication from O. L. Cartwright). Adults and larvae of *Aphotaenius* are common in cow and deer droppings in North Carolina from April 29 to September 10 (Cartwright, 1952).

TRIBE PSAMMODIINI

In Oregon, adults and larvae of *Psammodius* spp. have only been collected at the coastal dunes, under vegetation. In other parts of the United States, species of *Psammodius* have been collected along inland streams (Cartwright, 1955).

Adults and larvae of *Psammodius oregonensis* Cartwright were found throughout the year, at Waldport, Oregon, under vegetation. Larvae were found in the sand, six to eight inches below the surface, where the temperature ranged from 55-60° F. Adults were found just beneath the surface. Examination of the fore-gut contents of the larvae showed live plant tissue, indicating they feed on the roots of vegetation. Pupae and numerous newly transformed adults were collected during August and September.

On September 5, 1957, a trip was made to sample the coastal area from Oceanlake northwards to a point eight miles south of Astoria, Oregon. A great many adults and larvae (second and third-stage) were collected at numerous points along this area. They were common at a distance of about half a mile away from the ocean.

Adults of *P. oregonensis* from Waldport, Oregon, did not lay eggs in captivity even though eggs were in the ovaries. The length of pupal stage at room temperature was found to be from 10 to 12 days, but the mortality was very high. At 60° F. third-stage larvae pupated in 60 to 80 days after they were brought from the coast with the pupal stage lasting for 10 to 15 days. The mortality at 60° F. was about 8%.

Adults and larvae of *Pleurophorus* have been recorded occurring in soil or in dung (Mulsant, 1842). Larvae of *Pleurophorus caesus* (Creutzer) were collected in soil around roots of *Zinnia*

plants by J. B. Steinweden and P. C. Ting in an evergreen nursery at San Francisco, California, on June 11, 1934. Adults emerged on June 30, 1934.

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HESPEROCIMEX COLORADENSIS LIST IN OREGON

(Hemiptera: Cimicidae)

JOHN D. LATTIN[1] AND JOE SCHUH[2]

The junior author collected a series of *Hesperocimex coloradensis* List from an abandoned woodpecker nest at Prairie City, Grant County, Oregon, on April 25, 1959. This nest was in a fallen poplar tree and would have been approximately 25 feet

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from the ground. It was filled with dry blades of grass and contained in the neighborhood of 300 immature and adult bugs. These specimens agreed in all respects with the original description with the following exceptions: total length varied from 3.8–4.3 mm. as opposed to 3.3–3.8 mm; total width varied from 2.45–2.9 mm. as opposed to 2.1–2.6 mm. (the latter measurements in both cases were those cited in the original description); metasternum almost truncate posteriorly, lightly sinuate medially; anterior margin of pronotum almost straight. The differences in measurements may be attributed to the fact that the specimens were collected into alcohol and became somewhat distended. All other measurements of the various portions of the body less susceptible to expansion agreed with the original description in every way.

List (1925, Proc. Biol. Soc. Wash., 38:104), proposed a new genus, *Hesperocimex*, at the same time as he described *coloradensis* (*loc. cit.*, 104), to contain this new species. *Hesperocimex* may be distinguished from other cimicids occurring in the Pacific Northwest by the short beak (not reaching beyond the front coxae); triangular metasternum; rounded posterior margin of the scutellum and the non-reflexed lateral margin of the pronotum. *H. coloradensis* is generally considered a rare species, known previously from Colorado, Nebraska, California and Mexico. It is associated with the Purple Martin.

Prairie City is located in east-central Oregon in the southwestern foothills of the Blue Mountains at an elevation of 3,546 feet. This area contains certain elements of the Rocky Mountain fauna that extend in a southwesterly direction along the tops of the Wallowa and Blue Mountains. This species should be recovered from other localities within the state of Oregon.

The discovery of this species of cimicid brings the total to four species known to occur in Oregon; *Cimex lectularius* Linneaus, fairly common throughout the state; *Cimex pilosellus* (Horvath) on *Myotus*, known from only three localities in the state but concentrated collecting should prove it to be common wherever bats occur; *Oeciacus vicarius* Horvath, associated with swallows from several localities in the state, also should be rather widely distributed; and *Hesperocimex coloradensis* List. Close attention to cimicids occurring with bats and birds may disclose additional species for this region.

JAPYGIDAE OF NORTH AMERICA 2. THE GENUS HOLJAPYX AND DESCRIPTIONS OF NEW SPECIES

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The genus *Holjapyx* was established by Silvestri (1948) to contain the single American species *diversiunguis*. This species was originally described as *Japyx diversiunguis* by Silvestri in 1910. No other species of this genus have been described to date from America. Pagés (1952) described ? *H. forsteri*, ? *H. forsteri archeyi*, and ? *H. punamuensis* from New Zealand but was doubtful that these species were properly assigned to *Holjapyx*. *H. forsteri* has 28 segments in the antennae, *H. punamuensis* has 33, and males of both species are without male sacs in the third and fourth abdominal segments. Further study of New Zealand japygids may establish their proper generic relationship. Paclt (1957) placed *Holjapyx* as a synonym of *Burmjapyx* Silvestri (1930). After studying the nine new species presented in this paper, I conclude that the genus *Holjapyx* is distinct from *Burmjapyx*.

Genus HOLJAPYX Silv. 1948, emend. L. M. Smith

Antenna with 26 segments, trichobothria subequal to M[1] on the same segment, terminal segment lanceolate, longer than wide with three placoid sensillae. First lamina of lacinia pectinate with five to ten teeth; a small spine between lamina three and four. Lateral subcoxal organs with one to four rows of long glandular setae and one row of shorter and much thinner sensory setae. Median subcoxal organ area wrinkled, without disculi or setae, except 2+2 minute setae at a 45° angle to mid-line. Styli with a distinct secondary cone, Sr = 0.25–0.38. Male (in most species) with a median ventral sac opening on the scutum of abdominal segments III and IV, each containing one to ten minutely plumose small setae directed toward the posterior. Postero-lateral angles of tergite VII obtuse, right, acute, or projected to rear as lobes. Segment X, W:L = 0.95–1.13, one or two median M. Acropygidium small, rounded. Rectum visible through tergite X with an irregular row of internal, short, stout setae directed posteriorly on each side of rectum eight to 28 setae per row.

Forceps: R=0.371–0.541, one prominent tooth on each forcep, predental tubercles of left forcep always biserrate, predental tubercles of right forcep usually uniserrate, but in some species biserrate. Post-dental margins of both forceps crenulate or smooth. Genital orifice of male ringed anteriorly with one row of extremely small setae and posteriorly with

[1] Abbreviations: M—macrosetae; m—submacrosetae; R—x/y, see fig. 20; x—distance from tooth to tip of left forcep; y—distance from basal articulation to tip of left forcep; Sr—ratio of length of secondary cone of stylus VII to length of stylus.

one row of 12 larger setae, genital papillae conical, as wide as long, each with about 45 setae, mostly on the mesad side. Genital orifice of female not ringed with setae, two short anterior papillae three times as wide as long and one pair of larger posterior papillae as wide as long; all papillae with normal setate and a few very short sense setae; on each side of the genital opening a small, slightly raised area with 5–10 short sense setae close together.

Type species: *Holjapyx diversiunguis* (Silv.). This genus is close to *Occasjapyx* but differs from it in the presence of five pectinate laminae on the lacinia, a single large tooth on each forcep, two more segments in the antennae, and setae in the rectum.

Holjapyx calaverasae L. Smith, new species

Female.—Head dorsum with about 12 + 12 M and 15 + 15 m, antennae typical, mandible with four distinct teeth, fifth, basal tooth indicated by small hump, inner surface of labrum with 11+11 similar, short, stout setae, outer surface of labrum with 26+26 setae of various sizes, first lamina of lacinia with four teeth, maxillary palpus with 12 setae, thumb of galea with nine sensory cones, tip of glossa of labium fringed with 23 setae, labial palpus W:L=0.46, with 6 M and 3 m. *Thorax*, pronotum prescutum 1+1 M and 1+1 m, scutum 4+4 M and 6+6 m, mesonotum prescutum 1+1 M and 1+1 m,scutum 5+5 M and 11+11 m, metanotum prescutum 1+1 M and 1+1 m, scutum 5+5 M and 11+11 m. Legs long, leg III 2.34 times length of forcep, dorsal apex of femur with a transverse row of five setae; large ventral setae per row on tarsus, 4. *Abdomen*, tergite I 3+3 M and 10+10 m, tergite II 4+4 M and 16+16 m, tergites III–VII 7+7 M and about 18+18 m, postero-lateral angles of tergite VII obtuse, not lobed, tergite VIII 5+5 M and about 14+14 m, tergite IX 3 + 3 m, tergite X 2 + 2 + 2 M and 11+11 m, carinae not sclerotized, setae in rectum about 15; pleura II–VII pleurite 1 m, pleuron 1 M and 6–8 m, sternum I apotome 3 + 3 M and 5 + 6 m, scutum 13+13 M and about 30+30 m, lateral subcoxal organs one-third as broad as distance between styli; two rows glandular setae about 60+60 and one row sensory setae 30+30, median subcoxal area typical, sternum II apotome without setae, scutum 17 + 17 M and 17 + 17 m, sterna III–VII similar to II, sternum VIII 7+7 M and 12+12 m, sternum IX 2+2 M and 3+3 m, sternum X 10+10 M and about 20+20 m, genitalia typical, sense setae on anterior papillae 2+3, sense setae clusters laterad of genital pore 7 + 7, sense setae on posterior papillae 3 + 3, Sr=0.83. *Forceps.* Left arm with one tooth, R=0.371 tooth distinct, not fused with postdental margin, predental tubercles 5/6 upper row a cluster of four basally (some specimens 4/5), and one distal removed, postdental margin curved, smooth with three faint denticles; right arm with one tooth, predental margin with two monoserrated denticles, postdental margin with eight obscure denticles basally.

Male.—Similar to female except: six very small setae mesad in

median subcoxal area, male sacs in III and IV without setae, Sr=0.32, median subcoxal organs with three rows glandular setae, setae in rectum 17, R=0.371, left arm forceps postdental margin smooth, curved, right arm forceps, postdental margin crenulate, curved.

Holotype female, one male paratype, seven female paratypes, and one juvenile, TWO MILES WEST OF SAN ANDREAS, CALAVERAS COUNTY, CALIFORNIA, March 25, 1958 (L. M. Smith and R. O. Schuster), altitude 1,000 feet, sandy clay loam soil, pH 8, 20° slope, under *Quercus wislizenii.*

Holotype female and paratype male in California Academy of Sciences; paratype females in the California Insect Survey, U.S. National Museum, and University of California, Davis.

Holjapyx schusteri L. Smith, new species

Female.—Similar to *H. calaverasae* L. Smith, except: first lamina of lacinia with 11 teeth, tip of glossae with 26–28 setae, labial palpus W:L=0.50 with 6 M and 2 m, dorsal apex of femur with a transverse row of four setae, tergite I 3+3 M, tergite II 5+5 M and 14+14 m, tergite IX 1+1 M and 2+2 m, tergite X 2+1+2, setae in rectum about 30, faintly plumose, postero-lateral angles of tergite VII acute, not lobed, sternum I scutum about 15+15 M, one row of 11+11 uniform m immediately anterior to lateral subcoxal organs, lateral subcoxal organs and median subcoxal organ each occupying 0.14 of the distance between styli, lateral subcoxal organs with 2–5+2–5 glandular setae in one row and one row of 10+10 sensory setae, one-third as long as glandular setae, sternum IX 3+3 M and 3+3 m, sense setae clusters laterad of genital pore 8+8, sense setae on posterior genital papillae 4+5, Sr=0.32.

Forceps, left arm with one tooth, R=0.385, tooth distinct, not fused with postdental margin, predental tubercles 6/7, postdental margin curved with 11 crenulations; right arm with one tooth, predental tubercles 1/2, postdental margin curved with 14 crenulations.

Male.—Similar to female except: labial palpus with 5 M and 4 m, lateral subcoxal organs with 2+2 large glandular setae (one specimen 3+4) and 8+9 small sensory setae, male sacs in III and IV not visible; genital orifice anterior plate with irregular arrangement of about 20 long setae, anterior to pore 21 very small irregularly arranged glandular setae, posterior to pore a regular row of 10 medium setae, posterior plate with about 40 large setae, genital papillae W:L=0.31 with about 20 setae, laterad setae twice as long as mesad setae, and one group of three very short sense setae laterad and one such seta near the tip, forceps as in female, R=0.427.

Holotype female, 1♂ paratype, 1♀ paratype, and 1♀ juvenile, ONE MILE WEST OF SAN ANDREAS LAKE, SAN MATEO COUNTY, CALIFORNIA, November 1956, November 1957, and January 1957, in soil, open grassland and under live oak (D. W. Price), and

1♂ collected by Mr. G. A. Marsh on Mount Diablo, Contra Costa County, California, February 15, 1953. Holotype and paratype ♂ in California Academy of Sciences; paratype ♀ and ♂ in U.S. National Museum.

I take pleasure in naming this species after Mr. Robert O. Schuster.

Holjapyx humidus L. Smith, new species

Female.—Similar to *H. calaverasae* L. Smith, except: first lamina of lacinia with 8–10 teeth, thumb of galea with 15 minute setae, tip of glossa of labium tipped with 32 setae, labial palpus W:L=0.47 with 10 M and 2 m, mesonotum and metanotum prescutum 1+1 M and 2+3 m, dorsal apex of femur with a transverse row of six setae, abdominal tergite I 2+2 M and about 15+15 m, setae in rectum 46 not visibly plumose, postero-lateral angles tergite VII acute but not lobed, sense setae on posterior genital papillae 4+4, tergum X 2+2+2 M, sense setae clusters laterad of genital pore 14+14, Sr=0.29. Forceps: R=0.454, left predental tubercles 5/7 upper row not grouped, no postdental tubercles.

Male.—Similar to male of *H. calaverasae* L. Smith, except: male sac III with about 16 bilaterally plumose setae, male sac IV with about 12 similar setae, Sr=0.27, setae in rectum 25, R=0.500, left forcep predental tubercles 6/7.

Holotype female, MENDOCINO, MENDOCINO COUNTY, CALIFORNIA, December 25, 1958, and paratype male same locality June 4, 1954 (J. R. Helfer). Both deposited California Academy of Sciences, San Francisco.

Holjapyx hyadis L. Smith, new species

Female.—Similar to *H. calaverasae* L. Smith, except: labial palpus W:L=0.40, with 6 M and 4 m, thorax mesonotum prescutum 1+1 M and 2+2 m, mesonotum, prescutum 1+1 M and 2+2 m, dorsal apex of femur with a transverse row of six setae, setae in rectum not visible, tergite I 2+2 M, tergite X 2+1+2 M lateral subcoxal organ with one irregular row of 25+25 long glandular setae and one row of 25+25 small sensory setae, sense setae on genitalia not visible, Sr=0.30, forceps: R=0.455.

Male.—Similar to male of *H. calaverasae* L. Smith except: first lamina of lacinia with six teeth, labial palpus W:L=0.36, dorsal apex of femur with a transverse row of six setae, median subcoxal organs with two rows glandular setae, male sacs in III and IV each with one simple seta, Sr=0.31, setae in rectum not visible, R=0.450, forceps left arm predental tubercles 5/5.

Holotype female and allotype male, KINGS MOUNTAIN, SAN MATEO COUNTY, CALIFORNIA, December, 1957 (D. W. Price). Kings Mountain is four miles north of Lahonda. The specimens were found in deep humus of redwood, madrone, and tan bark oak. The area probably remains moist throughout the year.

Holotype and allotype deposited in the California Academy of Sciences.

Holjapyx conspersus L. Smith, new species

Female.—Similar to female of *H. calaverasae* L. Smith except: labial palpus W:L=0.33 with 6 M and 6 m, pronotum scutum 4+4 M and 9+9 m, mesonotum prescutum 1+1 M and 2+2 m, dorsal apex of femur with transverse row of six setae, postero-lateral angles of tergite VII distinctly lobed, abdominal tergite I with 2+2 M, tergite X 2+1+2 M and about 11+11 m, carinae sclerotized, setae in rectum 17, lateral subcoxal organs with two rows of glandular setae, about 70+70, sense setae clusters laterad of genital pore 8+8, Sr=0.29; forceps R=0.474, tooth left arm fused with postdental margin, predental tubercles 6/8 upper row three large denticles proximal and three smaller denticles distal.

Male.—Similar to male of *H. calaverasae* L. Smith except: small setae absent in median subcoxal area, male sac III setae obscured, male sac IV with four small setae, minutely plumose, Sr=0.36, median subcoxal organs with two rows of glandular setae, setae in rectum obscured; forceps: R=0.467, left arm predental tubercles 3/5.

Holotype female and allotype male, THREE MILES NORTH OF SHARP PARK, SAN MATEO COUNTY, CALIFORNIA, February, 1958 (D. W. Price) in humus under chaparral, especially coffee berry, christmas berry, coyote brush and scrub oak. Holotype and allotype deposited in the California Academy of Sciences.

Holjapyx imbutus L. Smith, new species

Male.—Similar to male of *H. calaverasae* L. Smith except: trichobothria two-thirds as long as longest seta on same antennal segment, labial palpus W:L=0.40 with 6 M and 4 m, mesonotum prescutum 1+1 M and 2+2 m, setae per transverse row on dorsal apex of femora: leg 1 and 2, five each, leg 3, six; postero-lateral angles of tergite VII right-angles, tergite I with 3+3 M, tergite X 2+2+2 M, lateral subcoxal organs occupy 0.76 of distance between styli, three rows glandular setae, about 90+90, lateral genital papillae each with about 20 large setae mainly lateral, and a compact mass of about 35 setae mesad, male sac in III with three curved plumose setae, male sac in IV with one curved plumose seta, Sr=0.30, setae in rectum 19, R=0.438, forceps left arm predental tubercles 6/3 (others 4/4 and 6/7) tooth distinct, postdental margin straight, smooth, right arm predental tubercles typical, postdental margin straight with three distinct denticles near tooth and crenulations distad.

Female unknown.

Holotype male, ONE MILE NORTH OF MURPHYS, CALAVERAS COUNTY, CALIFORNIA, March 5, 1958 (L. M. Smith and R. O. Schuster), in humus under oak tree. Paratype ♂ and one juvenile, three miles west of San Andreas, Calaveras County, California, March 25, 1958 (L. M. Smith and R. O. Schuster), in wet humus

and soil; paratype ♂, Calaveras Big Trees, Calaveras County, March 5, 1958 (L. M. Smith and R. O. Schuster), in rotten redwood log, soil temperature 3" deep 4°C.

Holotype male in California Academy of Sciences, paratype males in the California Insect Survey and University of California, Davis.

Holjapyx insiccatus L. Smith, new species

Female.—Similar to *H. calaverasae* L. Smith except: 1st lamina of lacinia with seven teeth, maxillary palpus with 12 setae and two minute sensory cones at the apex, labial palpus W:L=0.23 with 6 M and 4 m, mesonotum and metanotum prescutum 1+1 M and 2+2 m, dorsal apex of femora with a transverse row of six setae, abdominal tergite I 2+2 M and 12+12 m, postero-lateral angles of tergite VII right angles, tergite X 2+1+2 M, carinae sclerotized, setae in rectum 26, simple, lateral subcoxal organs with three rows glandular setae, Sr=0.30, forceps, left arm predental tubercles 7/6, strongly developed, uniformly spaced, R=0.467, right arm predental tubercles two, postdental margin crenulate with 13 crenulations visible.

Male unknown.

Holotype female and paratype female, NINE MILES SOUTH OF MONTICELLO, NAPA COUNTY, CALIFORNIA, December 13, 1957 (L. M. Smith and R. O. Schuster), on grassy slope under stones, one juvenile same locality May 12, 1957 (L. M. Smith and R. O. Schuster).

Holotype ♀ in California Academy of Sciences, paratype ♀ in the California Insect Survey.

Holjapyx irroratus L. Smith, new species

Female.—Similar to *H. calaverasae* L. Smith except: maxillary palpus with 15 setae and two minute sensory cones at the apex, thumb of galea with 15 sensory cones, tip of glossa of labium fringed with 27 setae,

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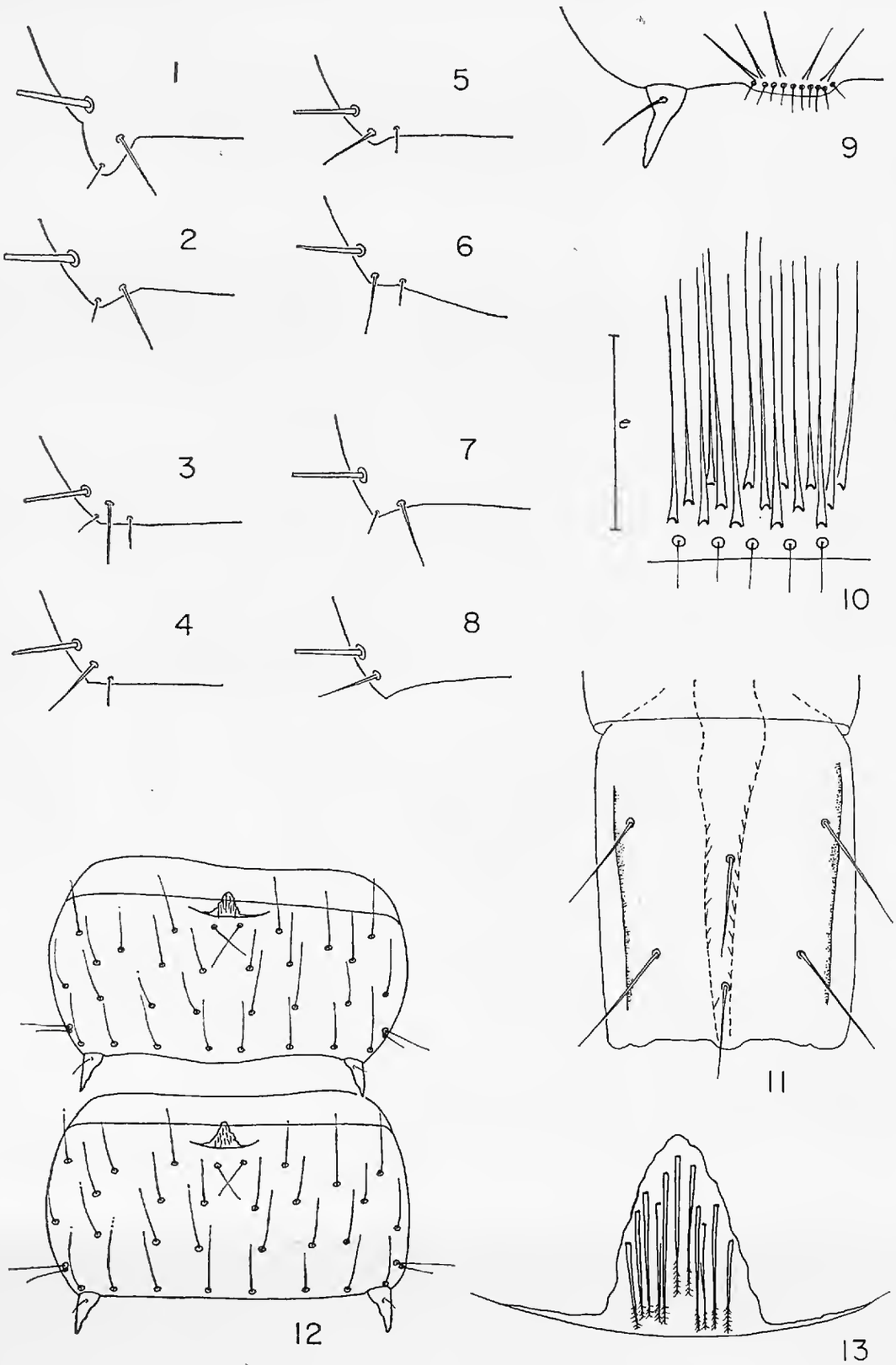
EXPLANATION OF FIGURES

Figs. 1–8, postero-lateral angles of seventh abdominal tergite: (e=0.50 mm.) 1. *Holjapyx conspersus* ♀, 2. *H. diversiunguis* ♀, 3. *H. humidus* ♀, 4. *H. madidus* ♂, 5, *H. irroratus* ♀, 6. *H. calaverasae* ♀, 7. *H. insiccatus* ♀, 8. *H. schusteri* ♀, 9. lateral subcoxal organ *H. schusteri* ♀ showing five glandular setae and ten sense setae, 10. small portion of lateral subcoxal organ of *H. humidus* ♂ showing three rows of glandular setae and one row of sense setae (e=0.054 mm.), 11. dorsal view of tenth abdominal tergite of *H. irroratus* ♀ showing 2+2+2 M and rectal setae (e=0.50 mm.), 12. ventral view of third and fourth abdominal sternites of *H. humidus* ♂ showing male setose sacs (e=0.50 mm.), 13. Male setose sac from fourth abdominal segment of *H. humidus.*

labial palpus W:L=0.34 with 6 M and 4 m, dorsal apex of femur with transverse row of six setae, abdominal tergite I 2+2 M and 10+10 m, postero-lateral angles of tergite VII acute, not lobed, tergite X 2+2+2 M, carinae sclerotized, setae in rectum 25, median subcoxal area slightly wider than either lateral subcoxal organ, lateral subcoxal organs with one row glandular setae 22+22, one row sense setae 25+25, sense setae



clusters laterad of genital pore 9+10. Sr=0.27, forceps left arm R=0.413, predental tubercles 6/6, postdental margin nearly smooth, curved, right arm tooth distinct, postdental margin with 10 visible crenulations.

Male unknown.

Holotype female and paratype female, ARMSTRONG STATE PARK, SONOMA COUNTY, CALIFORNIA, March 14, 1954 (J. Helfer), in humus under redwood trees. Holotype ♀ in California Academy of Sciences, paratype ♀ in the California Insect Survey.

Holjapyx madidus L. Smith, new species

Male.—Similar to *H. calaverasae* L. Smith except: outer surface of labrum with 19 setae, labial palpus W:L=0.34, with 6 M and 2 or 3 m, mesonotum prescutum 1+1 M and 2+2 m, abdominal tergite I 2+2 M and 10+10 m, male sacs in III with two plumose setae, IV with one similar seta, postero-lateral angles tergite VII obtuse, not lobed, carinae sclerotized, setae in rectum 15, sternum I apotome 3+3 M and 2+2 m, lateral subcoxal organs with one row glandular setae, 24+24, Sr=0.37, forceps left arm, R=0.532, predental tubercles 4/4, tooth fused with postdental margin, postdental margin smooth, curved, right arm predental tubercles 1/1, postdental margin slightly crenulate, curved.

Female unknown.

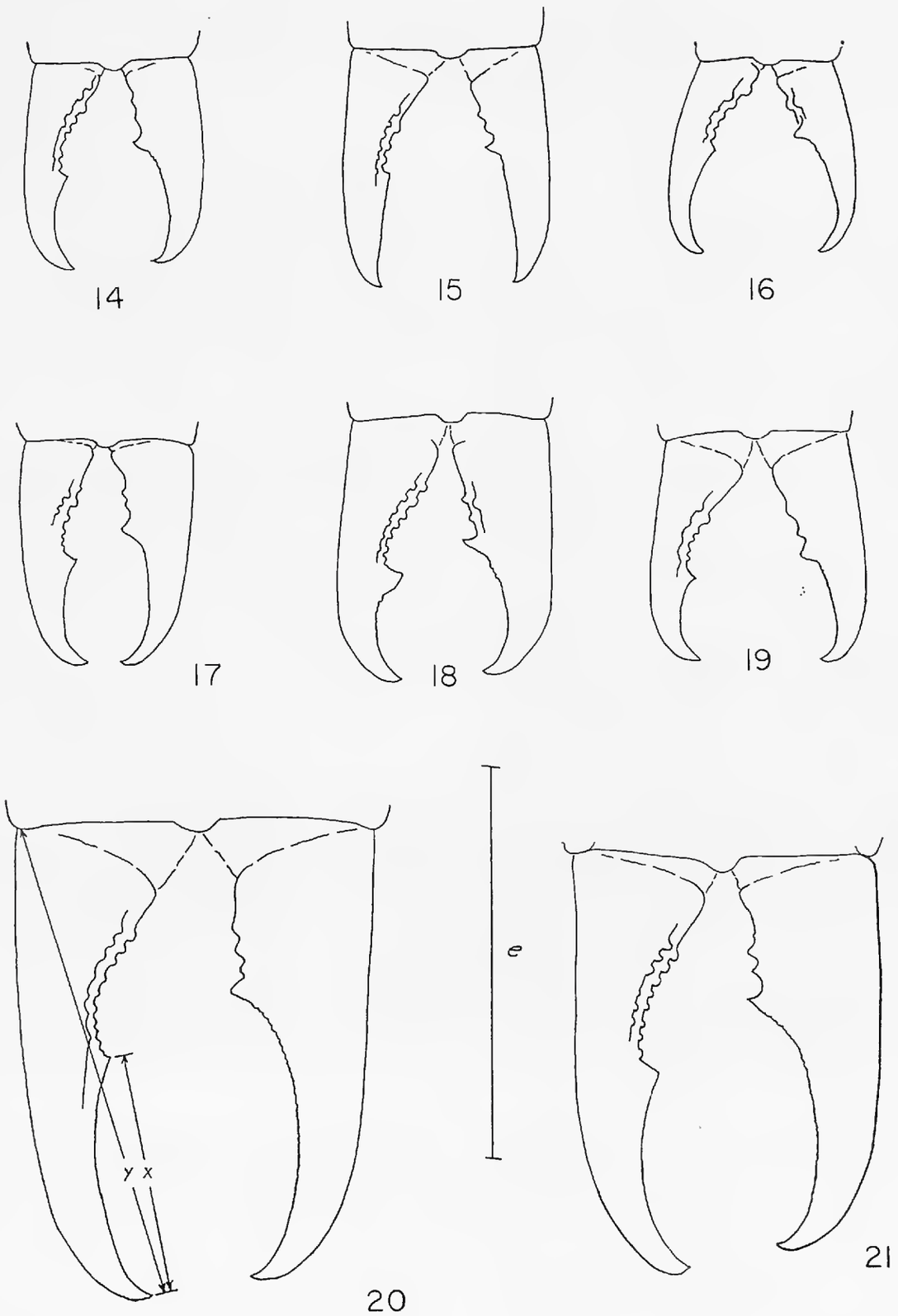
Holotype male, NEAR NASHVILLE, EL DORADO COUNTY, CALIFORNIA, March 5, 1958 (L. M. Smith and R. O. Schuster), in rocky soil, deposited in the California Academy of Sciences.

HOLJAPYX DIVERSIUNGUIS Silvestri

Female.—Similar to *H. calaverasae* L. Smith except: first lamina of lacinia with 10 teeth, maxillary palpus with 17 setae, labial palpus W:L=0.34, abdominal tergite I 2+2 M and 10+10 m, postero-lateral angles of tergite VII obtuse, not lobed, tergite VIII 4+4 M and about 10+10 m, tergite X 2+1+2 M and 11+11 m, carinae sclerotized, setae in rectum 56 not plumose, lateral subcoxal organs with two rows of glandular setae about 55+55, and one row sensory setae 35+35, sense setae clusters laterad of genital pore 8+8, Sr=0.26, forceps left arm R=0.500, predental tubercles 8/7, tooth fused with postdental margin, postdental margin smooth, curved, right arm postdental margin crenulate with 14 crenulations visible.

Male.—Similar to the female above except: male sac in III with eight plumose setae, male sac in IV with six plumose setae, Sr=0.28 median subcoxal organs with three rows of glandular setae, setae in rectum 52, not plumose, forceps left arm R=0.541, predental tubercles 7/9, right arm predental tubercles two or three, postdental margin crenulate with 17 crenulations visible.

Material examined: One male, Berkeley, California, March 24, 1938 (A. E. Michelbacher), determined by Dr. F. Silvestri, one male. Mill Valley, Marin County, California, May 5, 1950 (Hugh B. Leech), in damp soil, and one female Mill Valley, May 9, 1955, collected by Mr. Leech in soil.



EXPLANATION OF FIGURES

Figs. 14–21, dorsal view of forceps (e=1.00 mm.): 14. *H. hyadis* ♀, 15. *H. imbutus* ♂, 16. *H. madidus* ♂, 17. *H. conspersus* ♂, 18. *H. schusteri* ♀, 19. *H. calaverasae* ♂, 20. *H. diversiunguis* Silv. ♂, 21. *H. conspersus* ♀. R=x/y as shown in fig. 20.

KEY TO THE SPECIES OF HOLJAPYX SILVESTRI

1. Abdominal tergite X with 2+2+2 M 2
   Abdominal tergite X with 2+1+2 M 6
2. Abdominal tergite I with 3+3 M 3
   Abdominal tergite I with 2+2 M 4
3. Tooth on left arm of forceps fused with postdental margin, R=0.438 ..... *imbutus* L. Smith
   Tooth on left arm of forceps not fused with postdental margin, R=0.371 ..... *calaverasae* L. Smith
4. Predental tubercles on right arm of forceps 1/1, R=0.532 ..... *madidus* L. Smith
   Predental tubercles on right arm monoseriate, R less than 0.500 5
5. Lateral subcoxal organs with one row of glandular setae, 22+22 ..... *irroratus* L. Smith
   Lateral subcoxal organs with two or three rows of glandular setae, 60 to 100 + 60 to 100 ..... *humidus* L. Smith
6. Predental tubercles of right arm of forceps biseriate, 1/2 ..... *schusteri* L. Smith
   Predental tubercles of right arm of forceps uniseriate 7
7. Postero-lateral angles of seventh tergite distinctly lobed ..... *conspersus* L. Smith
   Postero-lateral angles of seventh tergite acute or obtuse, but not lobed 8
8. Postero-lateral angles of seventh tergite obtuse, rounded, in female R=0.463, lateral subcoxal organs with one irregular row glandular setae 25+25 ..... *hyadis* L. Smith
   Postero-lateral angles of seventh tergite, acute, slightly projecting, in female lateral subcoxal organs with two rows of glandular setae 50 to 65+50 to 65 9
9. Left arm of forceps with tooth distinct, female, R=0.463 ..... *insiccatus* L. Smith
   Tooth fused with postdental margin, female, R=0.500 ..... *diversiunguis* (Silvestri)

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A NEW BEMBICINE WASP RELATED TO STICTIELLA TENUICORNIS (FOX), WITH CERTAIN PHYLOGENETIC CONSIDERATIONS

(Hymenoptera: Sphecidae)

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Most of the specimens in museum collections under the name *Stictiella tenuicornis* (Fox) have been found to represent a new species which is here described in connection with publication of biological data elsewhere on the genus *Stictiella.*

Stictiella clypeata Gillaspy, new species

Stictiella tenuicornis, Parker, 1917:47 (part); 1929 (part).

Female.—Length 14–19 mm. *Color* black except lemon-yellow maculation as follows: posterior orbits exceeding inner angles of compound eyes but not meeting at middle of vertex; upright V above frontal pit with upwardly widening, outwardly rounded arms receiving anterior ocellus, sometimes extending somewhat ventrad along midline toward socketal maculation; maculate enclosures of sockets except above in some cases, sometimes attenuated above along midline; broad anterior orbits narrowing unevenly to eye margins above at vertex; clypeus, labrum and scape entirely; flagellar segments ventrally except apical segments brownish; pronotum except median area posterior to streptaular suture and smaller lateral spots; mesonotum laterally on scutum and in anteriorly arcuately emarginate band across scutellum (latter margined with black posteriorly) outlining black shield containing tri-partite or complete U formed of lateral clavate marks and often medially notched posterior bar; tegulae; postcutellum except narrow anterior crescent; propodeal triangle except basal crescent; posterior face, postero-lateral angles and sides of propodeum except extra-triangle wedges broadest at spiracles, forming a V; metepisterna, hypoepimeral areas and mesepisterna except narrowly along sutures and pre-mesocoxal spot on mesepisterna; coxae and trochanters except base of some; femora except narrowly above (rarely entirely yellow); tibiae except narrowly below and tarsal segments except distitarsi often dusky above; first tergite except anterior face and squarish-lobate dorso-median posterior extension from it, which may reach the transverse gradular swell and there exhibit tri-radiate tendency, indicating (in combination with apical black) paired elliptic or ovate maculae which are fused mesally and indistinct in this species; tergites 2–6 with elements of this pattern usually discernible, but anterior dorso-median lobe transversely barlike before gradulus, often basally detached, also medially divided or tending to be so on tergites 3–6, never so on tergite 2, and tergite 6 without apical black; sternite 1 except narrowly at base; sternites 2–6 except basal arc, progressively more strongly developed toward rear, trilobate on sternite 6. *Vestiture* of clypeus and anterior orbits consisting of very dense, flattened, silvery-appressed hairs, completely concealing the integumental surface. *Head* wider than

thorax at posterior pronotal lobes (1.08:1.00); vertex and temples weakly developed behind large compound eyes which bulge laterally beyond them; vertex moderately depressed on either side of median elevation which attains but scarcely exceeds upper level of compound eyes; lateral ocelli separated from compound eyes by less than their own distance apart (1.0:1.2), forming approximately a 65° angle with anterior ocellus; latter a glabrous, flattened, brownish, mostly light-pervious (except intrusive black opacity from below) surface, defined above by a distinct, horseshoe-shaped sutural arch, glabrous surface extending beyond open end of arch below without evident sutural delimitation from frontal integument (confirmable by slide mounts), anterior ocellus including sutural arch and maximum extent of glabrous area below one-third longer than broad (1.6:1.0), enclosed in mound which appears U-shaped but is weakly closed above, the crest describing an oval with length twice the width; frontal line weakly impressed to frontal pit, weakly elevated below; intersocketal carina arising at middle level of antennal sockets, distinct to apex of clypeus. *Clypeus* width more than half of head width (1.0:2.3), wider than distance between compound eyes at vertex (1.00:0.90), compound eyes therefore appearing to diverge below, with least interocular distance (between antennal sockets and frontal pit) more than one-third of head width (1.0:2.6); surface of clypeus not strongly arched or so protuberant as to exceed plane of intersocketal carina when viewed laterally, distal margin distinctly receding; basal third of clypeus with a planate area on either side, separated from remainder of clypeus by a distinct angle; epistomal suture distant from lower level of antennal sockets by one-half of intersocketal distance, almost straight or slightly elevated between subantennal angles, which are weak, sloping downward slightly to tentorial angles, base of clypeus broadly subtruncate between tentorial angles, lateral sections of epistomal suture curving outward to compound eyes, recurving to lateral angles. *Mouthparts* with labrum longer than basal width (1.2:1.0); maxillae apicad of palpal base in length equal to about one-half of head width (1.00:1.96); maxillary palpi with six segments, labial palpi with four. *Antennae* with scape moderately stout, length about three times greatest width. *Thorax* with punctation of mesoscutum and scutellum uniform; propodeal triangle formed by inwardly bowed, almost rectilinear sutures, converging on posterior face of propodeum at about a 60° angle. *Legs* moderately slender; distitarsi without strong erect bristles ventrally and with large, bulbous pulvilli extending one-third or one-half length of claws; claws all similar, uniform in curvature, outer claw of each pair very little longer. *Wings* beyond humeral plate two and one-half times thorax width, measured at posterior lobes (2.53:1.00); second cubital cell subrectangular, wider than high. *Abdomen* with tergites 2–3 having smallest lateral punctures, exclusive of those in unpigmented marginal area, in same general size and density range as those of subsutural area of first tergite, but less extensive in area on tergite 3; tergite 4 with some lateral punctures almost equivalent in size and density to lateral punctures of preceding tergites, but tergite 5 with punctures entirely larger or more sparse.

Male.—Length 14–19 mm. General appearance and pattern of markings quite similar to female except maculation slightly less extensive. Labrum, clypeus and frons devoid of appressed-silvery pubescence. Clypeus and labrum narrower than in female, basal planate area of clypeus less pronounced. *Antennae* with second flagellar segment not thickened as compared to segments distad of it; antepenultimate segment about one-third longer than its width (1.6:1.0); flagellar segments apicad of second sharply, longitudinally carinate, without evident specialized sensory areas or pits; flagellar segments 3–10 weakly excised distally on side inward to curvature of antennae; penultimate segment without inner apical process. *Legs* moderately slender; distitarsi moderately slender, widening apically, length about three times greatest width, all rather similar in form and size; anterior femora moderately slender, not dorso-ventrally thin; anterior tarsal segments 2–4 not distinctly lobed or flattened; middle femora weakly fusiform, smooth, not notched. carinate, or serrate, and without toothlike projection ventrally at apex; middle tibiae moderately slender, equal in length to middle femora; calcar of middle tibiae moderately slender, apically curved and blunt, thumblike, brownish; middle basitarsi straight, apparently terete, ventral surface beset with several (about five) evenly spaced bristles, without bunched bristles at base and without apical process; second and third tarsal segments not produced apically; posterior basitarsi slender, sub-cylindrical. *Abdomen* with seventh tergite narrowed at apex, indistinctly bilobed, dorsal preapical surface coarsely, sparsely punctate, not polished; lateral margins above spiracular lobes inflected, in part broadly groovelike, receiving dorsal margin of spiracular lobes, grooved surface bare but adjacent dorsal surface with a few long hairs and spines; spiracular lobes moderately narrow, separated across venter by twice width of either, thin but entirely sclerotized, at apex narrowing to a dorsal point; surface of spiracular lobes with only few setiferous punctures, these distad of spiracle, which is placed well before apex. *Sternites* 2–5 flat, unmodified; sixth sternite flat, apical margin weakly convex; eighth sternite with three terminal processes, median one equalling half of sternite length, lateral processes flattened, slender, discal process represented by a weak, obtusely pointed carina arising between lateral processes. *Genitalia* with parameres very slender, slightly membranous ventrally at base, ventral surface mostly rather well sclerotized and with sparse, rather long hairs; volsellae with cuspis slender, long, slightly exceeding digitus in length; digitus and aedeagus with slender, elongate heads.

This species resembles *S. tenuicornis* (Fox) in general appearance but is less extensively maculated than that species, specimens of medium maculation having a variegated, severely angulated pattern. Punctation generally, especially on abdomen, finer and more uniform than in *S. tenuicornis*. The most broadly maculated specimens are those from Imperial Co., California. The specimens from Mexcala, Guerrero, Mexico have considerable extension

of black, with total markings perhaps about equally black and maculate in the female, and extensive black in the basal planate areas of the clypeus, on the mesonotum, tarsal segments dorsally, and first sternite at base. In addition the parameres of the genitalia are somewhat more slender than usual in these specimens from Guerrero.

Holotype male from 33 MILES EAST OF DEMING, DONA ANA COUNTY, NEW MEXICO, 4300 ft., August 2, 1946, and allotype female from Alpine, Brewster Co., Texas, July 1, 1942, both collected by H. A. Scullen, both deposited in the collections of the California Academy of Sciences, San Francisco.

Paratypic material as follows.—ARIZONA: Cochise Co., Ash Canyon, Hauchuca Mts., ♂ ♀, VIII.31.51 (C. D. MacNeill, JEG); Benson, 2♂, VIII.8.40 (E. S. Ross, CAS); Chiricahua Mts., ♀, IX.20.49 (D. K. Duncan, CU); Chiricahua Nat. Mon., ♂, VIII.23.51 (Lloyd Martin, LACM); Douglas, ♀ (W. W. Jones, CIS); 30 mi. N. Douglas, ♂, VII.17.42, 45 mi. N. Douglas, 4950 ft., ♂, VII.31.46 (H. A. Scullen, OSC); Pearce, 25 mi. E., 2♂, VII.29.54, fls. *Baccharis glutinosa* (Butler-Werner, UA); Pearce, 5 mi. S., ♂, VII.28.55, on *Acacia angustissima* (G. Butler and F. Werner, UA). Graham Co., Coolidge Dam, 16 mi. E., 2500 ft., ♀, VIII.7.46 (H. A. Scullen, OSC). Mohave-Yuma Cos., Bill Williams Fork, ♀, VIII. (F. H. Snow, UK). Pima Co., Tucson, ♂, VII. (J. Bequaert, MCZ), 2♂, VII.12.24 (A. A. Nichol, UACAS), ♀, VII.15.41 (R. H. Crandall, UA), ♂, VIII.16.27 (P. A. Readio, UK), ♀, VIII.17.46 (H. A. Scullen, OSC), ♂ ♀, VIII.28.51 (C. D. MacNeill, JEG); ♀, VIII.29.– (F. M. Carpenter, MCZ), ♀, X.8.23 (C. D. Duncan, SJSC). Tucson, 15 mi. E., 6♂, 2♀, VIII.30.51 (C. D. MacNeill, JEG). Santa Cruz Co., Madera Cyn., Santa Rita Mtns., ♀, IX.11.51 (C. D. MacNeill, JEG). Yavapai Co., Congress Jct., 1♂, 3♀, VII. (F. H. Snow, UK. CALIFORNIA: Imperial Co., Experimental Farm, 2♂, V.–11, 14♂, 3♀, VI.–12, ♂ VI.6.12, on *Baccharis glutinosa*, 6♂, VI.–11, ♀, VI.–12 with prey *Tubifera latifrons* (Loew) (J. C. Bridwell, USNM). Riverside Co., Ripley, ♂, VIII.19.46 (P. D. Hurd, CIS); Shavers Well, ♂, IV.–.34 (G. E. Bohart, GEB). KANSAS: Kearny Co., ♀, VIII.20.52, swept *Solidago* (H. E. Evans, HEE). NEW MEXICO: Dona Ana Co., Las Cruces, 30 mi. W., 2♂, VII.23.54 (H. E. Cott, UCD). Eddy Co., Carlsbad, 2♂, VIII.17.51 (H. E. Evans, HEE); Loving, ♂, VIII.16.50 (J. W. MacSwain, CIS); Malaga, ♂, VII.11.36 (M. B. Jackson, UK). Grant Co., Lordsburg, 19 mi. E., 4600 ft., 19♂, VIII.1.46, 15 mi. E. ,4500 ft., 2♂, VIII.1.46 (H. A. Scullen, OSC); Separ, 3 mi. S., ♀, VIII.11.29, on *Salsola pestifer* (V. E. Romney, USNM). Hidalgo Co., Rodeo, 17 mi. N. of, 4200 ft., VIII.1.46 (H. A. Scullen, OSC). Luna Co., Deming, 20 mi. S., 4200 ft., 7♂, 2♀, VIII.2.46 (H. A. Scullen, OSC); 10 mi. E., VII.12.17 (R. C. Shannon, CU). TEXAS: Bexar Co., 2♂, V.25.31 (H. B. Parks, TAMC). Brewster Co., Alpine, ♀, VII.1.42, 2♂, VII.8.42 (H. A. Scullen, OSC); Chisos Mts., ♀, VI.10–12.08 (Mitchell

and Cushman, USNM); Dugout Wells, 2♂, VIII.25.54 (R. M. Bohart, UCD); Glenn Spring, 3♂, 9♀, VI.16–VII.3.28 (F. M. Gaige, UM); Santa Elena Cyn., 2145 ft., 2♀, VIII.25.54 (R. M. Bohart, UCD). El Paso Co., Sierra Blanca, ♂, VII.8.17 (CU); El Paso, ♀, VIII.19.54 (R. M. Bohart, UCD). Hudspeth Co., Cornudas, ♂, VIII.16.51 (H. E. Evans, HEE); Finlay, ♂, VII.2.30 (J. O. Martin, CAS); Salt Flat, ♂, ♀, VIII.16.51, on *Baccharis* (H. E. Evans, HEE). Jeff Davis Co., Ft. Davis, 10 mi. S., 1♂, 2♀, VI.30.42 (H. A. Scullen, OSC); White Rose Canyon, ♂, VI.18.47 (A. T. McClay, UCD). Midland Co., Midland, ♀, VI.6.13 (F. C. Bishop, USNM). Pecos Co., Pecos River, Sheffield, ♂, VII.26.21 (C. D. Duncan, SJSC). Presidio Co., Marfa, 4000 ft., ♂, VII.15.46, ♂, VII.30.36 (H. E. Evans, HEE); Presidio, ♀, VIII.14.29 (E. R. Tinkham, ERT). Webb Co., Laredo (inside automobile), ♀, VII.22.42 (USNM). MEXICO: Guerrero, Mexcala, 2♂, 2♀, VI.29.51 (H. E. Evans, HEE). Chihuahua, Chihuahua, 1♂, 2♀, VIII.12.51, on *Baccharis*, ♀, VIII.12.51 (H. E. Evans, HEE); Jimenez, 18 mi. W., 13♂, 2♀, VIII.10.51, on *Baccharis* (H. E. Evans, HEE); Villa Ahumada, 3♂, 1♀, VIII.14.51 (H. E. Evans, HEE). Coahuila, Paila, 3900 ft., ♀, VIII.21.47 (D. Rockefeller Exp., Cazier, AMNH).

Recorded Distribution.—Arizona: (Parker, 1917). New Mexico: Eddy Co., "Delaware Creek just north of state line" (Painter, 1932, 1936). Texas: Brewster Co., Chisolm (sic) Mts. (Parker, 1929); Glenn Springs (Steyskal, 1939); Reeves Co., 9 mi. S. of Texas-New Mexico state line on Texas Highway No. 17 (Painter, 1932, 1936); Webb Co., Laredo (Parker, 1929).

STICTIELLA TENUICORNIS (Fox)

Monedula tenuicornis Fox, 1895:368 (♀, not ♂) (Type: ♀, San Bernardino County California; Coquillett, USNM).

Stictiella tenuicornis, Parker, 1917:47 (part); 1929:43 (part).

Female.—Length 17–20 mm. *Color* black except light-yellow maculation which covers roughly more than three-fourths of total body area (compared with about three-fourths for most *S. clypeata* Gillaspy). Pattern essentially that of *S. clypeata* except some expansion of maculate loci and reduction of black loci; mesonotal U always tri-partite; anterior dorso-median lobe of first tergite rounded, tongue-like, never tri-radiate; elliptic-ovate maculae of first tergite very faintly indicated by apical black; anterior dorso-median lobe of tergite 2 represented by a pair of spots which are also represented on tergites 3–6.

Structural differences from *S. clypeata*: Least interocular measurement slightly higher, between anterior ocellus and frontal pit, ratio to head width nearer one-third (1.0:2.8); punctation of mesoscutum and scutellum not uniform, having interspersed larger punctures; abdominal tergite 2 with smallest lateral punctures, exclusive of unpigmented margin, in same size and density range as those of subsutural areas of first tergite; tergite 3 with smallest punctures perceptibly but not greatly larger; tergite 4 with distinctly coarser, sparser punctures.

Male.—Length 17–19 mm. Middle femora with large notch occupying most of apical third, the notch bearing an acute, inwardly directed process at base and apex; middle basitarsi straight, apparently terete, ventral surface with single longitudinal row of bristles and with thornlike process at apex, second and third tarsal segments of this leg similarly produced; seventh tergite with sides somewhat roundly tapering to narrow, distinctly notched apex; spiracular lobes separated across venter by somewhat more than width of either; genitalia with minor differences.

Recorded Distribution.—California: San Bernardino Co. (Fox, 1895).

Neallotype (present disignation): Male from CONSTANTIA, LASSEN CO., CALIFORNIA, August 2, 1951, on *Eriogonum* (J. E. Gillaspy, Collector), deposited in the collections of the California Academy of Sciences.

Material examined.—CALIFORNIA: Inyo Co., Owen's Valley, ♀, VIII.7.36 (G. E. and R. M. Bohart). Los Angeles Co., Palmdale, ♂, VIII.1.35 (E. I. Beamer). Riverside Co., Santa Rosa Mt., ♂, VI.15.48 (D. J. and J. N. Knull, OSU); Whitewater, 1♂, 1♀, VII.16.50 (P. D. Hurd, CIS). San Bernardino Co., Cushenbury Springs, 2♀, IX.1.36, on *Lepidospartum squamatum* (Timberlake, UCR, JEG); Yucca Valley, ♂, VIII.20.36, on *Croton californicus* (Timberlake, UCR); Victorville, 1♂, 1♀, VIII.14–15.27 (CU). NEVADA: Washoe Co., Reno, ♀, VII.16.40, ♀, IX.15.40 (Ira La Rivers, JEG, UN). MEXICO: Baja California, Sierra Juarez, ♀, X.10.53 (F. X. Williams, CAS).

In Parker's key the males of this species run to *S. divergens* Parker, a form which probably should be regarded as a subspecies of *S. femorata* (Fox). Differences of *S. tenuicornis* (Fox) from *S. divergens* are in the character of the middle femora, which in *S. divergens* are longitudinally emarginate through most of their length and in addition have a small apical notch; in the size, which does not exceed 13 mm. in *S. divergens*, and in the anterior ocellus, which in *S. divergens* is distinctly broader than long. The apical notch of the femora and strongly developed discal process of the eighth sternite distinguish *S. tenuicornis* males from those of *S. clypeata* Gillaspy. In the female the generally coarser, more widely spaced and less uniform punctation, specifically the coarser lateral punctation of the third and following tergites as compared with that of the first and second tergites, provides the principal character distinguishing *S. tenuicornis* from *S. clypeata*. The pair of pregradular black spots of the second abdominal tergite of *S. tenuicornis*, as compared

with the unified bar of *S. clypeata*, will also separate the females of all specimens I have seen.

These descriptions have been prepared with reference to all species considered by Parker to fall within his genus *Stictiella*, as well as certain undescribed species which differ in some respects from his generic diagnosis. Definable species groups, possibly worthy of designation as genera and/or subgenera, seem to be these: *S. pulla* (Handl.) group, [*exigua* (Fox), *argentata* (Fox), *scitula* (Fox)]; undescribed form with palpi reduced, pulvilli distinct; *S. pictifrons* (Smith) group, [*clypeata* Gillaspy, *tenuicornis* (Fox), *bituberculata* Parker, *terlinguae* C. L. Fox, *bifurcata* C. L. Fox, *megacera* Parker]; *S. emarinata* (Cress.) group, [*speciosa* (Cress.), *formosa* (Cress.)]; *S. pulchella* (Cress.) group, [*plana* (Fox), *serrata* (Handl.), *melanosterna* Parker, *callista* Parker, *tuberculata* (Fox)]; and the *S. femorata* (Fox) group, [*divergens* Parker].

A few characters believed to display the phylogeny of these wasps are: form and degree of opacity of the anterior ocellus; positional and form interrelationships of clypeus, compound eyes and antennal sockets; degree of reduction of pulvilli and palpi; comparative lengths of genital cuspis and digitus; modification of the parameres from flattened, bladelike form; length of maxillae and labrum; and degree to which the vertex is depressed. The *emarginata* and *pictifrons* groups appear to represent many primitive features of the Bembicini.

K. V. Krombein of the United States National Museum kindly compared specimens of *tenuicornis* and *clypeata* with the holotype of *tenuicornis*, and H. E. Evans brought to my attention the papers by Painter.

Institutional and individual collections are abbreviated as follows: AMNH, American Museum of Natural History, New York; CAS, California Academy of Sciences, San Francisco; CIS California Insect Survey, University of California, Berkeley; CU, Cornell University, Ithaca, New York; ERT, E. R. Tinkham, Indio, California; GEB, G. E. Bohart, Ogden, Utah; HEE, H. E. Evans, Ithaca, New York; JEG, J. E. Gillaspy, Montclair, California; LACM, Los Angeles County Museum, Los Angeles, California; MCZ, Museum of Comparative Zoology, Cambridge, Massachusetts; OSC, Oregon State College, Corvallis; SJSC, San Jose State College, San Jose, California; TAMC, Texas

Agricultural and Mechanical College, College Station, Texas; UA, University of Arizona, Tucson; UCD, University of California at Davis; UCR, University of California at Riverside; UK, University of Kansas, Lawrence; UM, University of Michigan, Ann Arbor; UN, University of Nevada, Reno; and USNM, United States National Museum, Washington, D.C.

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A RECORD OF PYRAMIDOBELA ANGELARUM KEIFER FROM SANTA CRUZ, CALIFORNIA

(Lepidoptera, Ethmiidae)

Pritchard and Powell[1] have recorded this species from San Mateo County, Alameda County and Contra Costa County, California. In the collection of the author are two specimens reared from *Buddleia* sp. from within the city of Santa Cruz, Santa Cruz County. The emergence date is September, 1947. The larvae were taken from rolled up leaves at the tips of the food plant, and the infestation was heavy, most of the tips being affected, indicating that the moth must have been well established. This note is presented as another link in the distribution of this moth, which seems to follow plantings of its introduced host plant.—J. W. Tilden, *San Jose State College, San Jose, California.*

[1] Pritchard, A. E., and J. A. Powell, 1959. Pan-Pac. Ent., 35(2) :82.

BIOLOGICAL OBSERVATIONS ON PSAMMAECIUS ADORNATUS (BRADLEY)

(Hymenoptera: Sphecidae)

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The solitary wasps of the gorytine genus *Psammaecius* are ground nesting species which utilize membracids and cicadellids as prey. Most of the known biological information on the North American species is based on two eastern species, *P. costalis* (Cresson) (Reinhard 1925a, b) and *P. tricolor* (Cresson) (Evans, Yin, and Yoshimoto 1954). Evans *et al.* have reviewed the literature on the biological knowledge of the genus in their discussion of *P. tricolor*.

An active nesting site of *Psammaecius adornatus* (Bradley) was located May 17, 1958 on Mt. Diablo, Contra Costa County, California. Intermittant observations were made during the afternoon of that day, and the same site was revisited on May 21 during the morning hours. The species was found nesting at Arroyo Seco, Monterey County, California at approximately the same time by E. G. Linsley, J. W. MacSwain and R. M. Bohart, and they contributed additional observations.

We are indebted to several specialists for the determination of the species cited below: Dr. R. M. Bohart, University of California, Davis (the *Psammaecius*, Nyssonini and Chrysididae), Dr. F. R. Cole, University of California, Berkeley (Bombyliidae), W. E. Ferguson, University of California, Berkeley ,Mutillidae), Professor H. J. Reinhard, Texas A. and M. (Sarcophagidae) and Miss Louise Russell, U.S. National Museum (Membracidae). Acknowledgment is also made to Marius S. Wasbauer, University of California, Berkeley, for reading the manuscript and offering helpful suggestions.

The Mt. Diablo site was located along the sandy border of a level, gravel-covered parking area at an approximate elevation of 1500 feet on the southwest slope of the mountain. The unshaded area occupied by the site extended in a five foot wide strip for about 65 feet along the edge of the roadway. There were estimated to be 60 to 80 active female wasps within this area during the period of observation, however nearly all of the observations were made in a zone of about five by ten feet where over half of the wasps were concentrated. Ground cover here was sparse,

consisting of scattered clumps of *Erodium cicutarius* l'Her. and a small amount of grass, oak leaves and other debris. The weather during the two days of observation was essentially clear and warm, although on the latter (May 21) some high cloudiness reduced activity slightly at times.

Accumulated observations over the two days indicated a general behavior pattern for the females as follows. The night is apparently spent removed from the site. Morning observations began at 8:10 A.M. (Pacific Daylight Time) while the sun was still partially obscured by morning fog and activity at the site had not yet commenced. Females were soon observed, apparently flying in from other areas. The first was observed at 8:45, and by 9:15 individuals were fairly numerous about the observation area. At first the females alighted on open areas in the sunlight, remaining still or only moving the body up and down. Individuals went through these motions for 10 to 20 seconds before flying a short distance away. It is assumed that this was a warming up process. Following this, the females crawled about and scratched in the loose surface sand for some minutes before finally selecting a suitable burrow site. The search for burrow sites had begun by 9:15 (when it was already quite warm) and many successful burrows were under way by 9:30. Digging operations continued for about two hours before provisioning began, which by noon was well under way. The prey consisted entirely of membracid nymphs, primarily a species of some genus of Ceresini, possibly *Stictocephala*, although two females were taken on May 17 with nymphs of a larger prey species, possibly some genus of Telamonini. The transport of prey to the burrows lasted through the afternoon until temperatures began to drop. A few wasps were still evident around the site after 5:30 P.M., but none with prey. It seems unlikely that the females spend the night in their burrows since we were unable to recover any during evening excavations in the nesting area. We were unable to determine the location of the resting sites of the females.

Males were collected about the site during the early afternoon hours at the height of provisioning activities but not in the morning while the females were digging. One male was swept from a nearby oak, the host of the membracids, late in the afternoon.

Apparently a new burrow is constructed by the female each morning. The precise location of burrows varied; most were in open areas, often in slight depressions, some were adjacent to pebbles or other debris, while others were under oak leaves or under clumps of *Erodium*. The digging process seemed to be rather consistent, with only slight individual variations. The digging was commenced with the forelegs, the wasp always being directed head first. As the burrow deepened, sand was kicked back almost continuously with the hind legs. After five to ten minutes the wasp had lengthened the burrow so as to disappear completely into it. As the burrow progressed, the length of time spent in the burrow increased with the wasp periodically reappearing. Upon each reappearance the wasp would back-up four or five centimeters from the entrance, pause a few seconds, then gradually progress forward to the entrance kicking the loose sand behind. This procedure resulted in a shallow trackway of loose sand curving away from the burrow. During the initial stages of the digging the wasp could be seen reappearing often, however after half an hour or more of the operation, from three to over five minutes were usually spent below the surface. In the final stages the wasp reappeared head first forcing the sand out ahead of her. After this type of emergence the female would repeat the previously described procedure of removing the loose sand. Construction of the burrow took two to two and one-half hours in the few cases in which the entire process was observed. This appeared to be the approximate time required for most of the burrows since most of the individuals in the colony began provisioning at about the same time. The earliest time of completion of any burrow under surveillance was 11:20 A.M.

The first indication of termination of the digging operation was the behavior of the female in covering the entrance. Sand was kicked backward over the aperture from all sides, periods of kicking being alternated with short hovering flights one to two cm. above the burrow. After two or three minutes the burrow was reentered for a few seconds. Upon emergence the entrance was again covered and the wasp resumed the short hovering flight, this time six to eight cm. high. In one instance this reentry and covering process was twice repeated. Following the short flights, the female made several longer hovering arcs

a meter or more above the burrow site before flying away. It is assumed that this behavior pattern, involving repeated coverings of the burrow and hovering flights, is one of area recognition by the female wasp.

Although the first female was seen to return with prey at 10:57 A.M., provisioning of most burrows did not begin until nearly an hour later. By noon the burdened females were appearing almost continuously.

Each of the wasps carried the prey in a similar manner, grasping it with the hind legs. The treehopper nymph was held under the wasp's abdomen in a venter-up position with its head oriented forward. The wasps were usually first seen flying into the nesting area with prey two or three meters above the ground. Upon attaining a position approximately above the burrow at this height, the female initiated a very characteristic descent. Assuming a hovering action, the wasp rapidly dropped to within a meter of the sand while orienting herself into a position directly over the burrow. The final part of the descent was made with gradually diminishing speed, requiring eight or ten seconds, until the wasp briefly hovered just above the burrow before alighting. After a few seconds pause the female quickly opened the burrow entrance with her fore legs and entered, without changing the position of the prey. Usually about 20 seconds (8 to 30 seconds) were spent in the deposition of the prey. Usually the burrow entrance was covered upon each departure. Closure after the first time or two was affected by merely kicking sand backward over the entrance from one direction before flying directly off. There was considerable variation expressed by every individual observed in the time required for provisioning flights and there was no apparent correlation in differences between the length of time required by individuals. One made 14 observed trips ranging from two to 20 minutes with an average of nine minutes, another made nine trips ranging from two to 17 minutes and averaged ten minutes. A third ranged from three to 14 minutes in 11 trips averaging about seven minutes. It is not definitely known at what distance the source of prey was located, but *Stictocephala* nymphs were swept in small numbers from nearby (20-30 feet distant) *Quercus agrifolia.*

Observations were interrupted in the early afternoon on May 17 for 40 minutes and concluded in the evening at 4:15 P.M.

before the provisioning activities had ceased entirely, so that the number of trips per day is not definitely known. Judging from the frequency of trips during the observation periods in the two days, it is estimated that about 20 to 25 nymphs were carried in each day. Since it was later determined that each cell was provided with 12 or 13 membracids, we assume that the normal pattern of activity involves the provisioning of two cells each day. However, in our excavation we were unable to definitely correlate two cells with any particular burrow.

When our excavations were commenced at 5:30 P.M. there were still one or two wasps active about the site, but provisioning had apparently ceased. The filling of the tunnels had already been completed and was not observed. We found that it was impossible to trace the tunnels of marked burrows in these evening excavations. Evans *et al.* (1954) state that *P. tricolor* (Cr.) probably fills the burrow by scraping sand from the sides, and a similar behavior with *P. adornatus* seems probable and would account for the obliteration of the tunnel. Subsequent excavation of open burrows in the early afternoon of May 21 revealed the nature of the tunnels.

The soil in the area was found to consist of an upper layer of unconsolidated fine sand about seven or eight cm. in depth with an underlying layer of hard packed clay loam. Seven of the burrows were successfully exposed by tracing their courses with dry straws. These were found to show considerable variation in formation but not in depth. In general the tunnels were found to be about seven cm. in length (range 6.5 to 17 cm.) angling into the ground at about 30° to 40° with one bend, usually about halfway along the length but sometimes immediately after the entrance. The bend varied from 60° to 90° laterally from the original course either to the right or left with a steepening sometimes occurring after the bend. The tunnel terminated in an oval cell measuring about 6 mm. by 15 mm. with its long axis oriented with the tunnel direction. Nearly all of the cells were found just at the base of the loose sand, about 5 to 6 cm. below the surface.

In addition to the cells associated with the tunnels, numerous other cells were uncovered, presumably the result of earlier activity by the colony. Fully provisioned cells were found to contain 12 to 14 ceresine nymphs. However one cell contained

11 telamonine nymphs and two of the smaller Ceresini. Several of the wasp eggs were also covered. The whitish egg is elongate, smooth and slightly curved, tapering at both ends and measuring about 2.5 mm. in length and 0.5 mm. in width. The position of the egg was constant, lying longitudinally along the venter of the thorax of the treehopper just laterad of the coxae. One small larva and one fairly mature larva were found. These were presumed to be those of *P. adornatus* although numerous adults of three nyssonine parasites were active in the area.[1] In feeding, the larva removes the contents of the prey body, leaving the exoskeleton intact except for the abdominal sternites or the entire sternum.

A number of insects of parasitic groups were collected in the nesting site during the two days of observations, certain of which seem to have a definite relationship with *P. adornatus*.

Two species of *Epinysson* and one *Nysson* were seen in numbers about the nesting area. Since members of the group are said to be cleptoparasites of gorytine wasps (Evans *et al.*, 1954), these seem to be definitely associated with the species under study. The most abundant of these was *Epinysson moestus* (Cresson) both sexes of which were active during most of the day. Females of this species were taken at the nesting site before 9:00 A.M. while still very sluggish and behaving similarly to the early *Psammaecius* females. Activity of both sexes was quite pronounced before construction of the burrows by *P. adornatus* had been completed and continued throughout the afternoon. Individuals were frequently seen investigating or entering open burrows or other holes. One was seen to enter a burrow with the digging occupant inside. The parasite emerged about three seconds later, flew out a few inches, reentered the burrow, and then both came out after a few seconds. Another was observed to dig its way into a temporarily closed burrow and remain within for almost eight seconds. The wasp, a female, was collected upon its reappearance. Six females and three males of *Epinysson pumilis* (Cresson) were taken during the afternoon, and 12 females of *Nysson rusticus* Cresson were also collected while the provisioning of *Psammaecius* was in progress. A single male of the latter nyssonine was taken late in the afternoon.

[1] The larvae have been sent to H. E. Evans for further study.

Several additional species known to be parasites of Hymenoptera were observed but had no apparent definite association with *P. adornatus* other than their occurrence in the nesting area. The hymenopterous parasites included the following: Chrysididae; *Omalus cressoni* Aaron, one female and *Hedychridium* sp. three females, (both species collected in the afternoon). Mutillidae; *Dasymutilla californica* (Radoszkowski), two females (11:10 A.M., 4:30 P.M.) and *Sphaeropthalma* sp., one female (8:30 A.M.). Among the Diptera were: Bombyliidae; *Lepidanthrax inaurata* Coquillett, one male and female (afternoon), Sarcophagidae; *Senotainia* sp. nr. *vigilans* Allen, one female (afternoon), *Senotainia trilineata* van der Wulp, one female (late afternoon), *Metopia leucocephala* (Rossi) two females (late A.M.).

Additional observations by Linsley, MacSwain, and Bohart on *Psammaecius adornatus* (Brad.) at Arroyo Seco, Monterey County, California showed that the nesting activities were going on concurrently with the Mt. Diablo population. The provisioning behavior at the Arroyo Seco colony was reported to be almost identical with that described above. The prey here also consisted of an undetermined membracid nymph.

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A NEW SPECIES OF CHAETOSTOMA FROM CALIFORNIA

(Diptera: Tephritidae)

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The tephritid herein described has been confused for many years with *Chaetostoma rubida* (Coquillett) because of its close relationship to that species. D. W. Coquillett described *rubida* in 1899 and placed it in the genus *Epochra*. The type (U.S. National Museum No. 4397) is from Colorado.

Recent study of California *Chaetostoma* specimens in the

various private and institutional collections on the Pacific Coast reveals that these are all distinct from the type material of *rubida* (Coq.) and from other *Chaetostoma* specimens from Colorado and Montana.

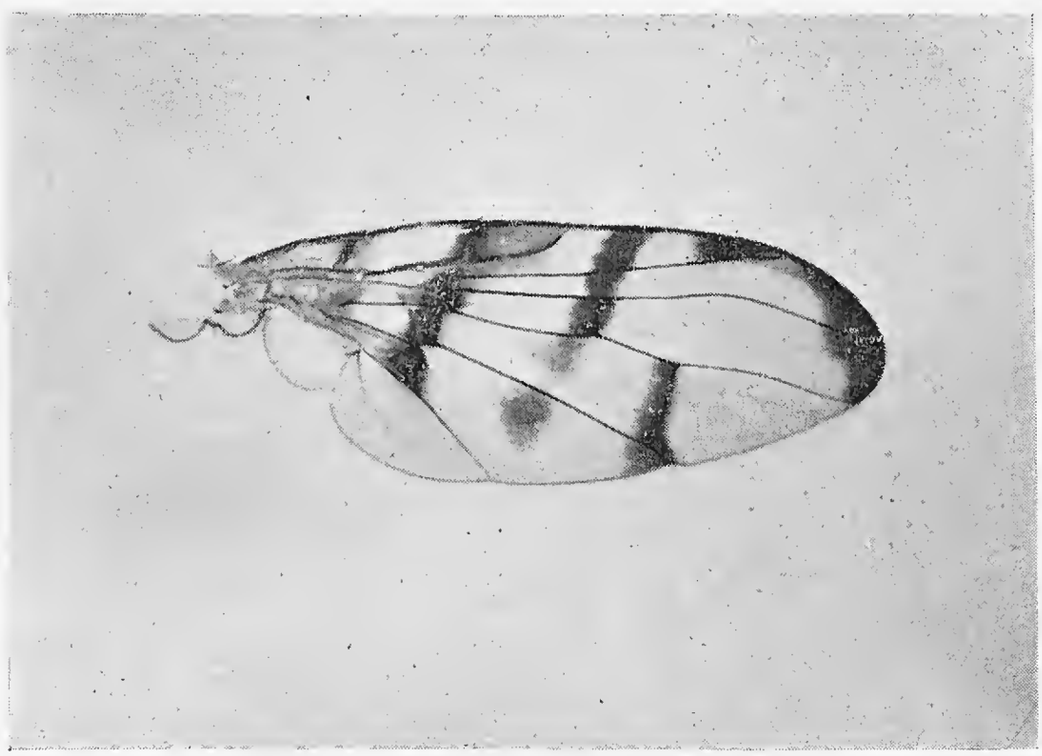
Chaetostoma elizabethae Quisenberry, described from Northern Colorado, is a synonym of *C. rubida* (Coq.). (New synonymy.)

Chaetostoma californica Blanc, new species

Male.—Head: Front orange to straw-colored, surface with sparsely scattered short, fine setae; front wider at vertex than width of one eye. Three pairs of black lower fronto-orbitals; two pairs of black upper fronto-orbitals which curve almost directly caudad. Antenna approximately as long as face, with terminal segment straw-colored tinged with pink, thinly grayish pruinose; arista bare and black except for light brown base. Face pale golden yellow blending to deep orange and faintly pruinose with white; face in lateral view only weakly protruding. Oral edge of bucca with a row of about 10 coarse, black bristles with a few finer black setae at the posterior end of the row. *Thorax:* Mesonotum deep orange, faintly pinkish in posterior portion, thinly white pruinose, rather uniformly covered with closely set fine, short, brown setae. Dorsocentrals on a line with supraalars. Scutellum orange, faintly rose-pink in center at base; two pairs of long black scutellar bristles; a few minute dark-brown setae beginning just cephalad to anterior scutellars and extending almost to posterior scutellars. Mesopleuron glabrous, yellow-orange to ochreous, with a white-to-pale-yellow band extending longitudinally caudad from just beneath the humeral bristle, extending along the dorsopleural suture to the wing attachment. Mesosternum near median line and anterorventral surfaces of all three pairs of coxae clothed with numerous long, black bristles. Femora orange to ochreous, tinged with rose in the central portion of each segment; hind femora with three strong setae before the apex dorsally; tibiae yellow, becoming pale near apices; tarsi pale yellow dorsally and white ventrally. *Wing:* (fig. 1)Hyaline with five brown maculations as follows: first begins at junction of costa and humeral crossvein and extends posteriorly to bases of the second basal and anal cells; second originates at juncture of costa and auxillary veins and extends posteriorly, crossing parallel and bordering mesally on basal crossvein, ending at distal point of the anal cell; third extends posteriorly from a point on costa one-third the distance from apex of first longitudinal vein to apex of second longitudinal vein, continues along the length of anterior crossvein, ending about half way through third posterior cell; fourth begins at (or very slightly anterior to) juncture of fourth longitudinal vein and posterior crossvein, then follows the crossvein posteriorly, meeting caudal wing margin at (or slightly mesad to) terminus of fifth vein; fifth maculation begins at costa about two-thirds the distance from apex of first vein to that of second vein and extends posteriorly only as far as second vein, but extends distally along costal wing margin to apex of fourth vein, the band becoming narrow or extinct at apex of second vein. Stigma

non-transparent yellowish-white. Third longitudinal vein dorsally with 17 well-spaced black setae extending from base to slightly beyond anterior crossvein. Juncture of anterior crossvein with discal cell slightly less than two-thirds the distance from basal crossvein to posterior crossvein. *Abdomen:* Glabrous orange to ochreous tinged with rose; fifth abdominal tergite bearing a large, round reddish-brown to black maculation dorso-laterally; tergites evenly covered with short fine setae; distal tergites each with a row of longer black bristles on the caudal margin; genitalia with forceps abruptly bending posteriorly at about a 35° angle, claws of forceps attached so that their extremities almost reach apices of forceps, the latter bearing one or two long setae close together and just beneath the tips of the claws.

Female.—Same as male in chaetotaxy and color except lacking the large dorso-lateral maculation on the fifth abdominal segment.



EXPLANATION OF PLATE

Fig. 1. Wing of *Chaetostoma californica* Blanc.

Holotype male: LA MESA, SAN DIEGO COUNTY, CALIFORNIA, February 11, 1957 (G. L. Hill), deposited in the California Academy of Sciences. Allotype female: San Ysidro, San Diego County, California, June 6, 1957 (J. L. Johnson); deposited in the California Academy of Sciences.

Paratypes: 29 males and 36 females (all from California) as follows: *San Diego County:* 1♀, La Mesa, Jan. 8, 1959, J. Gaven; 1♀, La Mesa, Mar. 11, 1959, G. L. Hill; 1♂, San Ysidro (4 miles E.), Feb. 11, 1957, Edward Soukup; 1♀, San Ysidro, June 10, 1957, J. L. Johnson; 1♂, San Ysidro, Sept. 6, 1957, R. D. Hancock; 3♂♂ and 2♀♀, Alpine,

Jan. 27, 1959, D. Close; 5♀♀, Alpine, Mar. 2, 1959, D. Close; 2♂♂, Hipass, Dec. 20, 1958, D. Close; 1♂ and 6♀♀, Campo, Jan. 28, 1959, S. M. Klopfer; 1♂, Campo, Feb. 19, 1959, D. Close; 1♂, Pine Valley, Nov. 29, 1958, D. Close; 1♀, Tecate, Dec. 18, 1956, G. L. Hill; 3♀♀, La Posta, Feb. 28, 1959, D. Close; 1♀, El Cajon, Mar. 2, 1959, D. Close; 1♀, Guatay, Feb. 28, 1957, Wiest; 1♀, La Jolla, Mar. 11, 1957, S. M. Klopfer; 1♀, Fallbrook, Feb. 6, 1957, D. F. Palmer; 1♀, Dulzura, Aug. 9, 1959, D. Close; 1♀, Winter Gardens, Mar. 3, 1959, D. Close. *Los Angeles County:* 1♂, Long Beach, July 12, 1957, Paul Engler. *Santa Barbara County:* 1♀, Carpinteria, May 13, 1959, I. B. Treloar; 1♀, Summerland, Aug. 12, 1957, Guy Beevor; 1♂, Santa Barbara, Sept. 4, 1957, Guy Beevor and H. T. Osborn; 1♂, Goleta, Sept. 18, 1957, Guy Beevor; 1♂, Goleta, Sept. 19, 1957, Guy Beevor; 1♀, Goleta, Oct. 21, 1958, Marcus Cravens. *San Luis Obispo County:* 1♀, Atascadero, Nov. 12, 1958, J. Williams. *San Mateo County:* 1♂, Redwood City, Sept. 19, 1957, Max Leonard; 1♀, Redwood City, Aug. 1958, R. C. Lauder; 1♂, Portola, Oct. 22, 1958, San Mateo County Department of Agriculture. *Alameda County:* 1♂, Castro Valley, Sept. 20, 1957, Jerry Marston; 2♂♂ and 1♀, Fremont, Sept. 12, 1957, Ralph Freeman; 1♂, Centerville, Aug. 1953, R. P. Allen; 2♂♂ and 2♀♀, Centerville, Nov. 21, 1958, Johnson and Sibray; 1♂, Berkeley, Oct. 6, 1907, H. H. P. Severin; 1♂ and 2♀♀, "Hills back of Oakland," Oct. 6, 1951, W. C. Bentinck; 1♂, Livermore, Aug. 1958, T. R. Haig; 1♂, "Alameda County," Sept. 13, 1956, T. Enos. *Sonoma County:* 1♀, Petaluma, July 25, 1957, F. K. Jarvinen; 1♂, Glenn Ellen, July 15, 1957, M. G. Dornbush; 1♂, Santa Rosa, Sept. 15, 1956, T. B. Gallion.

Paratypes are deposited with U.S. National Museum; California Insect Survey (University of California, Berkeley); University of California (Davis, California); and the Bureau of Entomology, California Department of Agriculture, Sacramento, California.

Chaetostoma californica Blanc differs decidely from the closely related *rubida* (Coq.) in the nature of the brown wing maculations. In *rubida* the fourth and fifth bands definitely join at the costal margin of the wing. The fourth and fifth maculations of *californica* are widely separated, the fourth extending anteriorly barely past the juncture of the fourth longitudinal vein and the posterior crossvein.

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OCCURRENCE OF SPERMATOPHORES IN CERTAIN SPECIES OF CHILOCORUS

(Coleoptera: Coccinellidae)

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During the past ten years several species of diaspine-scale-feeding coccinellid beetles have been under propagation at the Citrus Experiment Station, Riverside, California, the host being mainly latania scale, *Hemiberlesia lataniae* (Signoret), on potato tubers. In the routine inspections for eggs and small larvae among the host scales, some peculiar, rather pyriform pellets were encountered in the cultures of *Chilocorus* spp.[1]

A culture of *Chilocorus cacti* (Linnaeus) was started in the fall of 1954 from a small colony taken from mesquite in southeastern Arizona. During a study of the larval characteristics of this species, numbers of the peculiar pellets were observed in the debris of the culture cage.

EXPLANATION OF FIGURE

Fig. 1. Left to right, fecal castings, eggs, and spermatophores of *Chilocorus discoideus* Crotch, an African species that produces a larger spermatophore than does *C. cacti*. Scale is in millimeters.

Observations on the origin of the pellets showed that (1) unmated females produced no viable eggs and no pellets; (2) a group of mated females produced viable eggs and fewer pellets

[1] The interest and assistance of M. E. Badgley, Senior Laboratory Technician, is gratefully acknowledged.

than there were females; (3) a group of unmated females placed and held with males eventually produced viable eggs and more pellets than there were females; (4) males alone produced no pellets. These observations were facilitated by the obvious sexual dimorphism in the adults of *C. cacti*. A correlation between mating and pellet formation was thus indicated and suggested the possibility of the pellets being spermatophores. A survey of the literature revealed no mention of spermatophores as occurring in the Coccinellidae. Cros (1924) and Khalifa (1949) reported spermatopores in the Coleoptera only in the families Cantharidae, Chrysomelidae, Curculionidae, Dytiscidae, Meloidae, and Scarabaeidae. The present study shows that the family Coccinellidae, as represented by eight species of *Chilocorus*, belongs in this list. Spermatophores were found in *Chilocorus cacti, C. discoideus* Crotch, *C. distigma* Klug, *C. fraternus* LeConte, *C kuwanae* Silvestri, *C. orbus* Casey, *C. stigma* Say, and a new species from Kenya.

Attempts to determine the source and function of the pellets were made along two lines: (1) the chemical and/or physical nature of the pellets, and (2) their functional role. *Chilocorus discoideus* only was used in this study (fig. 1).

Physical properties: The voided pellets are roughly pyriform, 0.8 × 1.5 mm. in size, pearl white or yellow to brown in color, and are hollow with a small orifice at the narrow end. The wide end is closed. Under 3600 Angstrom units of ultra-violet light the pellets fluoresce brightly both from their outer and inner surfaces.

Chemical properties: The Van Wisselingh test for chitin gave a negative response. When held in distilled water, glacial acetic acid, and 10% KOH, the pellets become soft and rather amorphic. These solvents also become fluorescent. Ethyl alcohol (95%) seemingly does not change their appearance nor does it become fluorescent. A preliminary biochemical analysis showed indications of fat, protein, and carbohydrates.

Functional role: The relationship of the pellets to mating has already been mentioned. Observation of pairs of *Chilocorus discoideus* revealed that they remained in copula for 40 to 105 minutes. The females voided the pellets as hollow bodies 18 to 24 hours later. From a group of both sexes which contained 30 females, the number of cast-off pellets indicated that each female mated an average of 32 times during a four-month period. Gross

dissections at intervals during copulation subsequently resolved the probable source and function of these pellets.

The female of a pair was dissected 30 minutes after copulation began. The bursa was then seen to be filled with a semifluid undifferentiated mass which contained no sperm. There were no sperm in the spermatheca. Another copulating female was examined after 40 minutes and sperm were seen near the inner tip of the mass, which now was definitely known to be a spermatophore. At this time some sperm had already moved into the spermatheca. Several females were dissected immediately following copulation. Each time the bursa was filled with a spongy mass, sperm were in the spermatheca as well as still swimming up the five mm. long sperm duct, and some were at the entrance of the sperm duct which is located (dorsally) at the extreme anterior end of the bursa.

Three hours after copulation the bursa is distended by the spermatophore. By this time the spermatophore is distinctly composed of an outer layer which fluoresces and an internal gelatine-like mass which does not fluoresce. Its general appearance is clearly that of the voided pellet. After 20 hours the *in situ* spermatophore is compressible and leathery in consistency. The voided spermatophore becomes hard within 30 minutes. Attempts were made to kill pairs *in copula* in order to establish the exact role of the male genitalia in sperm transfer and spermatophore formation. The technique used, however, did not accomplish the desired result. A study comparable to that of Blunck (1912), wherein serial sections of pairs of *Dytiscus marginalis* LeConte were made at intervals during copulation and the actual transfer of sperm and the construction of the spermatophore could easily be followed, is desirable.

Dissections of sexually mature males revealed that the accessory glands fluoresced brightly. It is of interest that in the body of the male each sperm travels about 34 mm. The testes and sperm from the spermatheca did not fluoresce nor did any organ or gland within the female.

It is apparent from the foregoing observations that the principal source of the spermatophore in *Chilocorus* is the accessory gland of the male. During copulation the glandular secretions enter the bursa of the female, expand, and consequently assume the general shape of the bursa. An outer layer becomes differen-

tiated as a semisolid and is referred to as the wall of the spermatophore. The exact nature of the nonfluorescent inner mass is not understood. It may be material previously secreted by the female and subsequently enveloped by the male's secretions during formation of the spermatophore. At any rate, it is believed that the sperm and associated fluids are ejected into the interior of the forming spermatophore.

Although the primary function, by definition, of the spermatophore is the transfer of sperm, it is thought that in *Chilocorus* other functions of importance are also performed. The swollen spermatophore and the attendant distension of the bursa could serve to prevent loss of sperm through migration away from the opening of the sperm duct.

Since the voided spermatophore has a definite pore at the anterior end, and since the pore is not apparent in the spermatophore *in situ*, it seems logical that the pore is formed by the sperm and associated fluids being forced through by the pressure of the swelling spermatophore upon its contents. The fact that the spermatophore when voided is empty (as is the bursa) suggests that the female either absorbs or voids its contents. The latter would be possible only after the spermatophore was passed.

Another possible function of the spermatophore is the preparation of the vaginal opening for oviposition. The passage of the spermatophore, by distending the opening, would allow the relatively free passage of the bulky eggs which follow.

The commonly observed low per cent of viable eggs deposited by *Chilocorus*, correlated with the need for repeated matings, is a probable result of a relatively inefficient fertilization mechanism.

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A NEW BIBIONIDAE FROM CALIFORNIA[1]

(Diptera)

D. ELMO HARDY

Hawaii Agricultural Experiment Station, Honolulu

One new species is on hand from the California Academy of Sciences collection which needs a name so that it might be included in my Bibionidae of California which is being published in the Bulletin of the California Insect Survey.

Bibio imparilis Hardy, new species

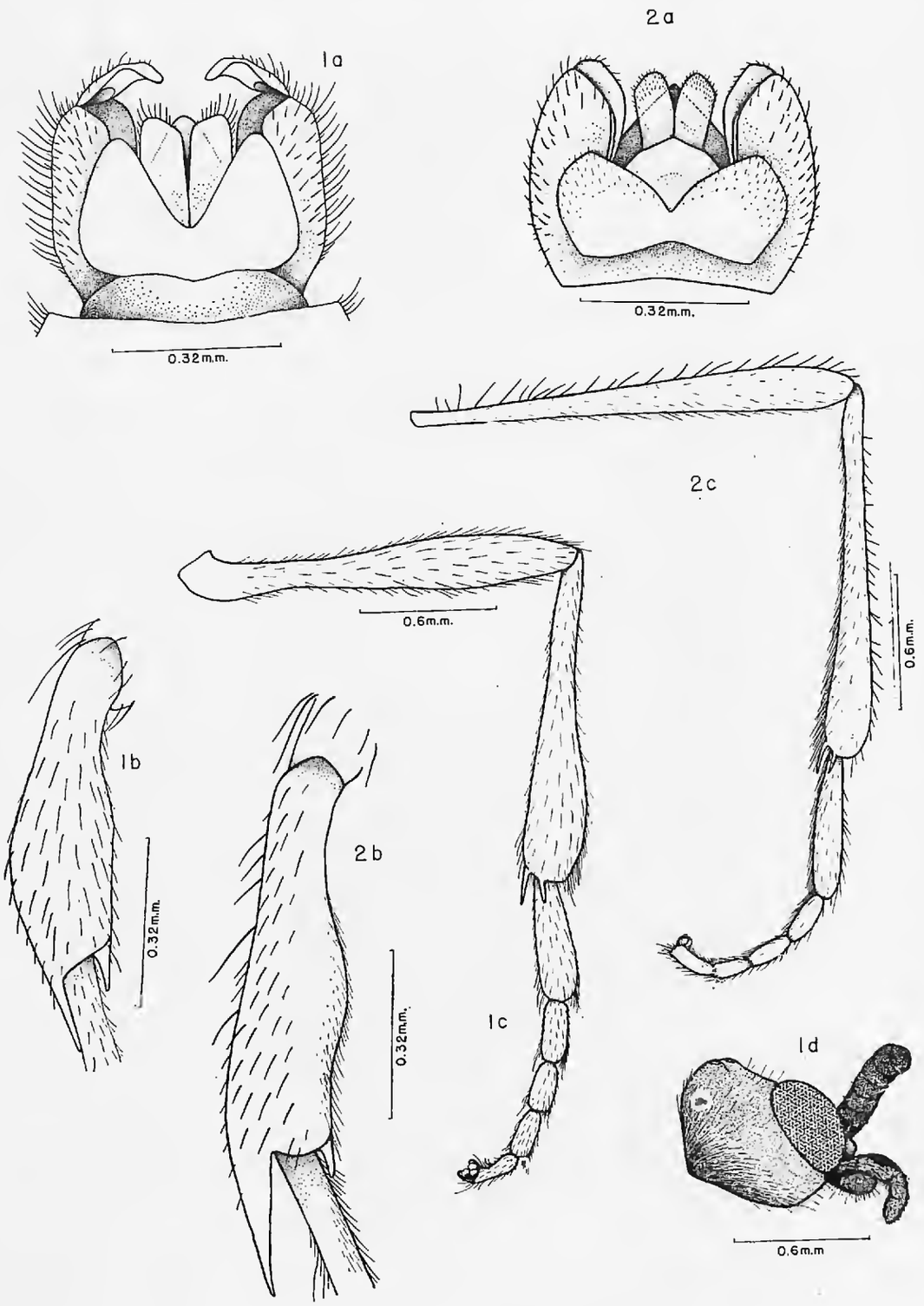
(figs. 1a–d)

This species fits rather closely to *B. townesi* Hardy but differs in many details. The hind femora, tibiae and basitarsi are not so slender, and the former two are not so long attenuated, compare figs. *1c* and *2c*. The male genitalia and the prothorax are entirely black, not predominantly yellow, and the genitalia are very different in development as shown in figs. *1a*. and *2a*. The antennae have only eight segments, counting the apical knob as two segments (fig. *1d*), not nine segments as in *townesi*. In both sexes, the costa extends distinctly beyond the apex of the radial sector, rather than extending at or near the apex. The coxae are brown to black, not yellow. The palpi are short with the segments not much longer than wide, rather than the palpi being elongate with the last two segments five or six times longer than wide. The females also differ by having the thorax and head predominantly black, not yellow.

Male.—Small, predominantly shining black species. *Head:* Antennae and palpi entirely dark brown to black, flagellum consisting of only five distinct segments, the large apical knob made up of two closely fused segments (fig. 1d). Palpi short, scarcely longer than lower division of compound eyes; apical segment slightly longer than wide; penultimate segment nearly two times longer than wide; second segment short, thick and flattened dorsally. Eyes rather densely covered with short, brown hairs; lower 2/5 of eye divided off into an area of smaller facets. *Thorax:* Shining black, except for the yellow humeral ridges and a faint tinge of rufous in ground color of the pleura and metanotum. Thoracic pile entirely yellow. Halteres dark brown, except for the yellow bases. *Legs:* Coxae and trochanters dark brown, remainder of legs yellow to rufous, except for last three segments of tarsi brown; apices of femora and tibiae tinged very lightly with brown. Front tibia shaped as in fig. 1b, inner spur short, scarcely one-quarter as long as outer. Hind femora and tibiae rather gradually tapered to bases, not strongly swollen apically. Hind tibia broader at apex

[1]Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 441.

than the femur. Hind tarsal segments slightly swollen, basitarsus about three times longer than wide (fig. 1c). *Wings:* Faintly colored yellow-brown, anterior portion slightly darker. Costa extending distinctly beyond apex of radial sector; *rm* crossvein slightly longer than basal section of radial



Explanation of Figures

Fig. 1. *Bibio imparilis* Hardy. *a.* male genitalia, dorsal; *b.* front tibia; *c.* hind leg of male; *d.* head of female. Fig. 2. *Bibio townesi* Hardy. *a.* male genitalia, dorsal; *b.* front tibia; *c.* hind leg of male.

sector; posterior veins yellow-brown, distinctly darker than wing membrane; *m* crossvein and basal portion of vein M_{1+2} beyond the crossvein are very faint, almost obliterated. *Abdomen:* Entirely black, covered with yellow pile. Ninth tergum with a deep U-shaped cleft on hind margin, extending two-thirds the length of the segment (fig. 1a). Ninth sternum cleft on hind margin about one-half its length. Claspers simple, moderately slender and subacute at apices.

Length: Body, 4.5 mm.; wings, 5 mm.

Female.—Fitting the description of the male in most respects. Coxae tinged with rufous, humeral ridges and hind portions of propleura yellow. From a dorsal view, head nearly quadrate in shape. Front about equal to width of one eye, portion of head behind compound eyes about equal to length of one eye (fig. 1d). Hind tibiae not swollen at apices, tarsal segments slender. Abdomen dark brown, tinged with red; cerci yellow, tinged lightly with brown.

Length: Body, 4.75 mm.; wings, 5.5 mm.

Holotype male, allotype female and three paratypes, all males, from YOSEMITE VALLEY, MARIPOSA COUNTY, CALIFORNIA, May 21, 1921 (E. C. Van Dyke). Holotype, allotype, and one paratype in the California Academy of Sciences collection. One paratype each in the United States National Museum and the University of Hawaii.

LABORATORY MANUAL FOR INTRODUCTORY ENTOMOLOGY by Clifford J. Dennis. Wm. C. Brown Company, Dubuque, Iowa. Loose-leaf spiral binding. Price $2.00.

Dr. Dennis, who is Associate Professor of Biology at East Central State College, Ada, Oklahoma, has presented a brief and simple manual covering subdivisions of Entomology. The work opens with a chapter on collecting and techniques, followed by chapters on a comparison between insects and other arthropods, external anatomy, mouthparts, antennae, legs, wings and internal anatomy. Life cycles, insect groups, ecology and insect control make up the remaining chapters. There are two short appendices, dealing with materials and collection arrangements.

Techniques and structure are covered adequately for a course of these dimensions. I cannot help but feel that the other areas have been short-changed a bit. Of special note is the short shrift given basic systematics and nomenclature, early stages, behavior and the various practical disciplines to which entomology can be a valuable adjunct.

Strong points are the well-thought-out syllabus-like arrangement of the chapters, and the omission of unnecessary details, often left to clutter up a general course.

The manual seems to supply an adequate and reasonably priced guide to an introductory course in the subject, but would not be advisable for a more extended or technical approach.— J. W. TILDEN, *San Jose State College, San Jose, California.*

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE: NOTICE OF PROPOSED USE OF PLENARY POWERS IN CERTAIN CASES (A.[N.S.]42)

In accordance with a decision of the 13th International Congress of Zoology, 1948, public notice is hereby given of the possible use by the International Commission on Zoological Nomenclature of its plenary powers in connection with the following cases, full details of which will be found in *Bulletin of Zoological Nomenclature*, Vol. 17, Parts 1/2, published on 1 October, 1959:

(1) *Orthoceros* Brüunnich, 1771, and *Orthocera* Modeer, 1789, suppression of (Classes Foraminifera and Cephalopoda) (Z.N.[S.]44);

(2) *Orthoceratites* Lamarck, 1799, suppression of (Class Pelecypoda) (Z.N.[S.]1395);

(3) *Prothechus* and *Alloneura* Rondani, 1856, suppression of (Class Insecta, Order Diptera) (Z.N.[S.]230);

(4) *Beraea* Stephens, 1833, designation of type-species (Class Insecta, Order Trichoptera) (Z.N.[S.]395);

(5) *Apantania* Kolenati, 1847, designation of type-species (Class Insecta, Order Trichoptera) (Z.N.[S.]427);

(6) *Aphrophora* Germar, 1821, designation of type-species (Class Insecta, Order Hemiptera) (Z.N.[S.]478);

(7) *Drepanella*, validation of (Class Crustacea, Order Ostracoda) (Z.N.[S.]1112);

(8) *Westonoceras*, validation of (Class Cephalopoda) (Z.N.[S.]1226);

(9) *saccharivora* Peterkin, 1790 *(Phalaena)*, suppression of (Class Insecta, Order Lepidoptera) (Z.N.[S.]1315).

Any zoologist who wishes to comment on any of the above cases should do so in writing, and in duplicate, as soon as possible, and in any case before 1 March, 1960. Each comment should bear the reference number of the case in question. Comments received early enough will be published in the *Bulletin of Zoological Nomenclature*. Those received too late for publication will, if received before 1 March, 1960, be brought to the attention of the Commission at the time of commencement of voting.

All communications on the above subject should be addressed as follows: The Assistant Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.—RICHARD V. MELVILLE, *Assistant Secretary to the Internation Commission on Zoological Nomenclature.*

TAXONOMY OF NEOTROPICAL PSYCHODIDAE (DIPTERA) 1. PSYCHODA SPECIES OF WEST INDIES AND CENTRAL AMERICA WITH A KEY TO TRINIDAD SPECIES

LARRY W. QUATE
Bishop Museum, Honolulu

The recent acquisition of a large number of Neotropical moth flies has prompted the inception of a series of papers dealing with the taxonomy of the family from this region. It is anticipated that most of the study will be descriptions of new species and unlisted Neotropical records of previously described species. It appears likely that the geographic area will be largely the northern Neotropical region, although if specimens from other parts of the region become available they too will be included in the series.

The bulk of the specimens studied in the preparation of the present paper were received from Dr. T. H. G. Aitken of the Trinidad Regional Virus Laboratory, and sincere appreciation is extended to him for procuring the specimens. Nearly all the Trinidad (B.W.I.) records are based on Aitken's material. Gratitude is also expressed to Dr. Alan Stone for arranging the loan of relevant psychodid material from the U.S. National Museum, most of which is from the Canal Zone.

PSYCHODA ICHTHYCERCA Quate

Psychoda ichthycerca Quate, 1959, Insects of Micronesia (Bishop Museum), 12(4), in press.

Specimens examined: TRINIDAD: Tucker Valley, U.S. Naval Sta., VI-56, VII-6-56, X-26-56, XII-17-56, light trap, (Aitken).

Distribution: Micronesia, Trinidad.

PSYCHODA ROTONGENSIS Satchell

Psychoda rarotongensis Satchell, 1953, Proc. Roy. Ent. Soc. London (B), 22:183; Quate, 1955, Univ. Calif. Publ. Ent., 10:208.

Psychoda lucia Quate, 1954, Proc. Hawaiian Ent. Soc., 15:349.

Specimens examined: NICARAGUA: Rama, Zelaya, VII-20-43, (Woke), COSTA RICA: Higuito, San Mateo, (Schild); San Pedro de Montes de Oca, X-32, (Ballou). PANAMA: Trinidad Rio, VI-9-12, (Busck); Tobago Isl., IX-30-26, *ex.* ripe fruit *Spondias lutea,* (Moline). CANAL ZONE: Ft. Claiton, II-2-56, light trap; Ft. Kobbe, IX-50, light trap; Barro Colorado Isl., XI-41, reared from *Calathea violacea;* Mojinga Swamp, I-9-53, light trap. PUERTO RICO: El Semil, Villalba, V-30-42, (Hoffman). TRINIDAD: U.S. Naval Sta., (Aitken); Tucker Valley, U.S. Naval Sta., III-19-56, X-5-56, XI-9-56, XII-17-56; Chaguaramas, U.S. Naval Sta., II-27-56, V-21-56, VII-15-56, X-11-56, XII-28-56; Macqueripe, U.S. Naval Sta., II-25-56, VIII-17-56,

XI-9-56, XII-17-56; San Jose Point, U.S. Naval Sta., I-4-57, IX-27-56, XI-12-56.

Distribution: Solomon Is., Cook I., Micronesia, Hawaiian Is., U.S., Nicaragua, Costa Rica, Panama, West Indies.

This widespread species undoubtedly owes its extensive range to human dispersal and probably breeds in plant materials carried aboard ships. It was the most abundant species represented in the collections studied.

PSYCHODA COCHLEARIA Satchell

Psychoda cochlearia Satchell, 1950, Proc. Roy. Ent. Soc. London, (B), 19:181 (descr., illus.); Quate, 1959, Insects of Micronesia (Bishop Mus.), 12(4), in press.

Specimens examined: CANAL ZONE: Ft. Kobbe, IX-50, light trap. TRINIDAD: Macqueripe, U.S. Naval Station, II-25-56, light trap, (Aitken); Tucker Valley, U.S. Naval Sta., VII-16-56, XII-17-56; Chaguaramas, U.S. Naval Sta., XII-28-56.

Distribution: Fiji, Micronesia, Canal Zone, Trinidad.

Psychoda zetoscota Quate, new species

(Figures 1, 2)

Female. *Head:* eyes separated by distance equal to one facet diameter; interocular suture absent; eye bridge with four rows of facets; frons with median band of hair extending posteriorly and nearly joining hair area of vertex: labellum with four teeth and two spines; palpus about one third the length of antenna, ratio of segments 4:5:5:7. Antenna with 15 segments, 14 and 15 separate, 15 about half the size of 14. *Wing:* Sc ending little before level of base of R_1; bases of R_3 and M_2 lacking. *Genitalia* as figured; subgenital plate subrectangular with moderate apical concavity; genital digit present.

Measurements: holotype, antenna 0.7 mm.; wing length 1.2 mm.; wing width 0.6 mm. Paratypes, wing length 1.1–1.3 mm.; wing width 0.5–0.6 mm.

Male unknown.

Holotype female (U.S. National Museum): FORT CLAITON, CANAL ZONE, February 2, 1956, light trap. Paratypes, three females, same data. Other specimens: TRINIDAD; Tucker Valley, U.S. Naval Station, 27-VII-56, light trap, (Aitken).

Distribution: Canal Zone, Trinidad.

P. zetoscota is closely allied to the Formosan species *formosana* Tokunaga (1957, Sci. Rpt. Saikyo Univ. Agric., No. 9, p. 61) on the basis of the close similarity of the wing venation and female subgenital plate, but differs in that the antenna is 15-segmented and 16-segmented in *formosana.*

PSYCHODA PLATILOBATA Tokunaga

(Figures 3, 4, 5)

Psychoda platilobata Tokunaga, 1957, Sci. Rpt. Saikyo Univ. Agric., No. 9, p. 65.

Male. *Head:* eyes separated by distance equal to less than one facet diameter; interocular suture absent; eye bridge with four rows of facets; frons with median band of hair extending posteriorly and joining hair area of vertex; labellum with four teeth and two spines; palpus about one third the length of antenna, ratio of segments 4:4:5:6. Antenna broken (see female); all sensory filaments Y-shaped. *Wing:* Sc ending near level of base of R_1; veins R_5 and M_4 very heavy; longitudinal veins with brown spots at apices, spots may be faint and indistinct; ratio of $R_{2+3}:R_2:R_3=7:6:9$, ratio of $M_{1+2}:M_1:M_2=6:12:10$. *Genitalia* as figured; dististyle with several irregular rows of spines, paramere pointed with notch before apex.

Measurements: wing length 1.7 mm.; wing width 0.5 mm.

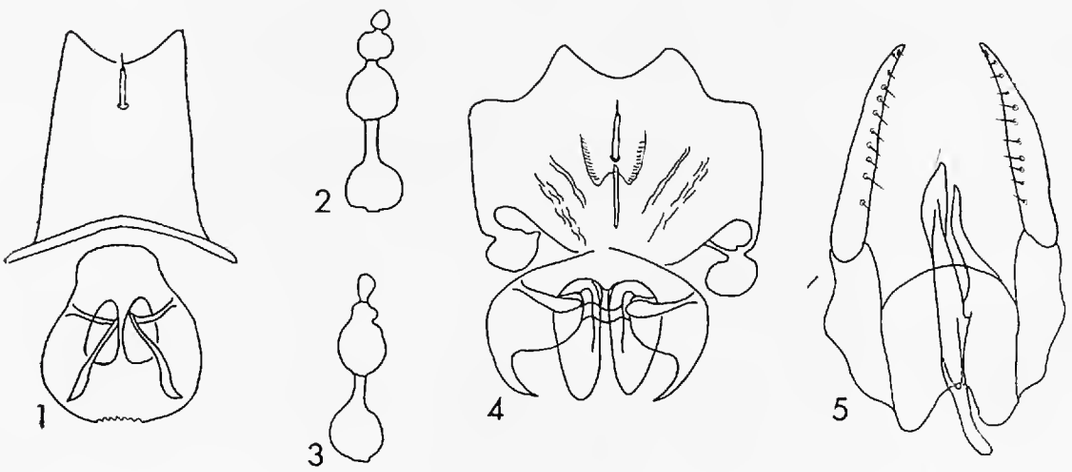
Female. Similar to male. *Head:* eyes separated by distance equal to one facet diameter. Antenna with 15 segments, 14 solidly fused to 13, 15 separate, about half the size of 14; 13 and 14 with tubercle-bearing spine. Sensory filaments dimorphic, those on third and fourth segments with three short arms, remainder Y-shaped. *Genitalia* as figured; subgenital plate heavily sclerotized, weakly bilobed.

Measurements: antenna 0.7–? mm.; wing length 1.2–1.6 mm.; wing width 0.5–0.6 mm.

Specimens examined: TRINIDAD: Tucker Valley, U.S. Naval Station, VI-56, VII-6-56, VIII-16-56, X-11-56, XI-1-56, XII-17-56. JAMAICA: Kingston, I-29-37, Sta. 361, (Chapin and Blackwelder).

Distribution: Trinidad, Jamaica, Formosa.

This common West Indian species may be recognized by the two heavy veins, R_5 and M_4, the spots at the tips of the veins, the genitalic structure of both sexes, but especially by



EXPLANATION OF FIGURES

Fig. 1. *Psychoda zetoscota* Quate, female genitalia. Fig. 2. *P. zetoscota* Quate, antenna tip, Fig. 3. *P. platilobata* Tokunaga, antenna tip. Fig. 4. *P. platilobata* Tokunaga, female genitalia. Fig. 5. *P. platilobata* Tokunaga, male genitalia, dorsal view.

the unusual subgenital plate of the female and the dimorphic antennal sensory filaments of the female.

In spite of the surprisingly discontinuous distribution of the species, there is little doubt that the Neotropical specimens are conspecific with the Formosan. The unusual features of the wing venation, antennal sensory filaments, and female subgenital plate are too similar to regard the specimens otherwise. (My drawing of the female subgenital plate differs from that of Tokunaga in outline because I have illustrated the internal shelf-like structure which apparently was lost in Tokunaga's dissection and gives the plate a more quadrangular appearance.)

Psychoda alternata Say

Psychoda alternata Say, 1824, Narr. exp. source St. Peter's River, 2:358; Quate, 1955, Univ. Calif. Publ. Ent., 10:218 (biblio., descr., and illus.).

Specimens examined: Mexico: Orizaba, I-3-08, (Knab); Cordoba, I-3-08, IV-1-08, XII-18-07, (Knab). Canal Zone: Ft. Kobbe, VIII-54, (Field); same, IX-50, light trap. Puerto Rico: Bayamon, I-21-34, (Anderson). Trinidad: Tucker Valley, U.S. Naval Station, III-19-56, VII-6-56, X-5-56, XI-9-56, light trap, (Aitken). Jamaica: Newport, II-20-37, (Chapin and Blackwelder).

Distribution: Cosmopolitan. Mexico, Canal Zone, Jamaica, Puerto Rico, Trinidad.

Psychoda alternicula Quate

Psychoda alternicula Quate, 1955, Univ. Calif. Publ. Ent., 10:222 (descr. and illus.).

Specimens examined: Mexico: Ciudad Valles, S.L. Potosi, XII-1-44, light trap, (Brookman). Canal Zone: Ft. Kobbe, IX-50, light trap. Trinidad: Tucker Valley, U.S. Naval Station, XII-7-56, light trap, (Aitken).

Distribution: U.S., Mexico, Canal Zone, Trinidad.

Psychoda lativentris Berdén

Psychoda lativentris Berdén, 1952, Opusc. Ent., 17:111; Quate, 1955, Univ. Calif. Publ. Ent., 10:217.

Specimens examined: Tlalnepantla, Mexico, XI-13-56, (Snow).

Distribution: Holarctic. Mexico.

This species is included here because it probably will be found in Central America. Most likely it will not show up in Trinidad, as the extensive light trap collections have failed to reveal it, and it is commonly taken at light in North America.

Psychoda gehrkeae Quate, new species

(Figures 6, 7)

Female. *Head:* eyes separated by distance equal to one facet diameter; interocular suture absent; eye bridge with four rows of facets; frons with median band of hair extending posteriorly and nearly joining hair area of vertex; labellum with four teeth and two spines; palpus about one-quarter the length of antenna, ratio of segments 5:5:5:5.5. Antenna with

16 segments, 14 and 15 partly fused, separated from 13; 16 separate, about one-half the size of 15; sensory filaments Y-shaped. *Wing:* Sc ending little beyond base of R_1; ratio of $R_{2+3}:R_2:R_3=8:7:10$; ratio of $M_{1+2}:M_1:M_2=7:14:12$. *Genitalia* as figured; subgenital plate with bulging sides and moderate apical concavity; genital digit long and slender.

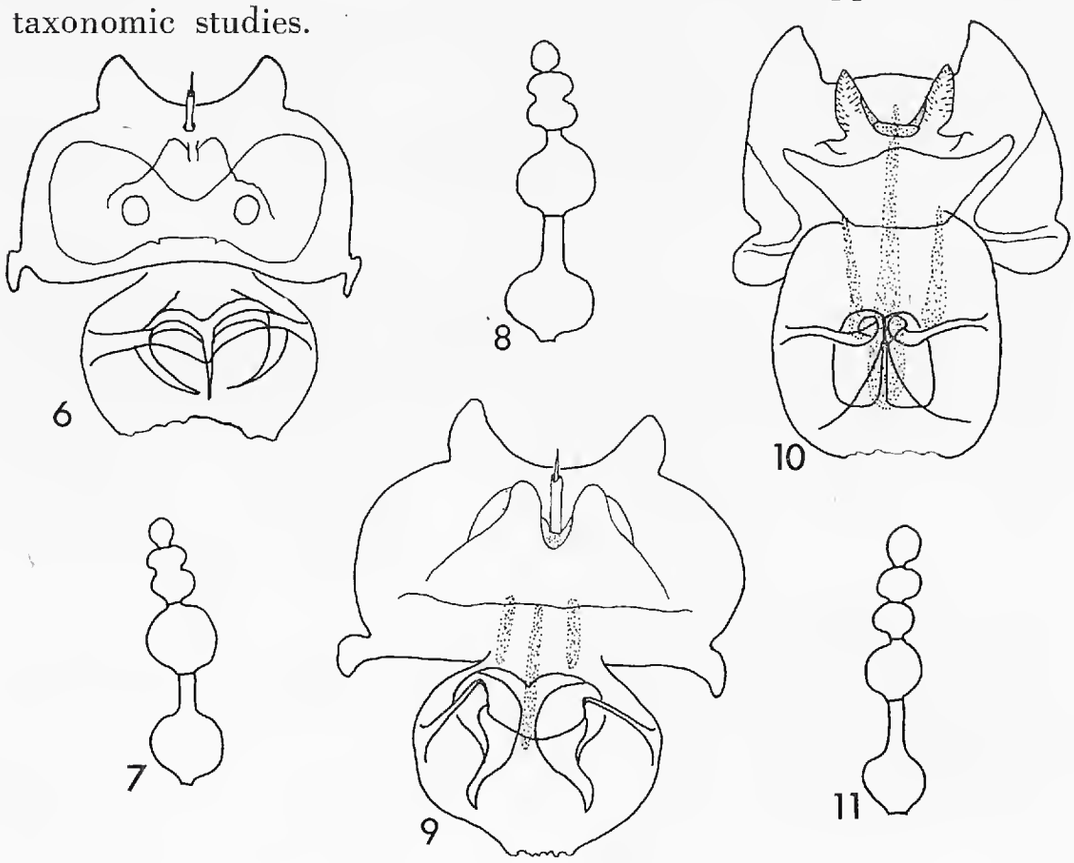
Measurements: holotype, antenna 0.8 mm.; wing length 1.3 mm.; wing width 0.5 mm. Paratypes, antenna 0.7–? mm.; wing length 1.3–1.6 mm.; wing width 0.5–0.6 mm.

Male unknown.

Holotype female (U.S. National Museum): TUCKER VALLEY, U.S. NAVAL STATION, TRINIDAD, November 19, 1956, light trap, (T. H. G. Aitken). Paratypes: four females, same data; one female, same data except VI-56; one female, same data except VII-16-56; one female, Macqueripe, U.S. Naval Station, Trinidad, VIII-2-56; one female, same data except XII-17-56.

Distribution: Trinidad.

This species is named in honor of Mrs. E. A. Gehrke in appreciation of her continued interest in and appreciation of taxonomic studies.



EXPLANATION OF FIGURES

Fig. 6. *Psychoda gehrkeae* Quate, female genitalia. Fig. 7. *P. gehrkeae* Quate, antenna tip. Fig. 8. *P. scotina* Quate, antenna tip. Fig. 9. *P. scotina* Quate, female genitalia. Fig. 10. *P. aitkeni* Quate, female genitalia. Fig. 11. *P. aitkeni* Quate, antenna tip.

Psychoda scotina Quate, new species

(Figures 8, 9)

Female. *Head:* eyes separated by distance equal to one facet diameter; interocular suture absent; eye bridge with four rows of facets; frons with median band of hair extending posteriorly to above level of center of eye bridge, almost joining hair area of vertex; labellum with four teeth and two spines; palpus short, about one-quarter the length of antenna, ratio of segments 6:5:5:6. Antenna with 16 segments; segments 14 and 15 partly fused together, 16 separate, smaller than preceding segments; sensory filaments Y-shaped. *Wing*: Sc ending beyond base of R_1; ratio of $R_{2+3}:R_2:R_3=9:8:12$, ratio of $M_{1+2}:M_1:M_2=8:16:14$. *Genitalia* as figured; apex of subgenital plate with two well defined lobes; genital digit long and slender.

Measurements: holotype, antenna broken; wing length 1.5 mm.; wing width 0.6 mm. Paratypes, antenna 0.8–0.9 mm.; wing length 1.3–1.5 mm.; wing width 0.5–0.6 mm.

Male unknown.

Holotype female (U.S. National Museum): FORT CLAITON, CANAL ZONE, February 2, 1956, light trap. Paratypes; 14 females, same data. Other specimens: TRINIDAD: Tucker Valley, U.S. Naval Station, VII-6-56, X-5-56, XII-17-56, light trap, (Aitken).

Distribution: Canal Zone, Trinidad.

Psychoda aitkeni Quate, new species

(Figures 10, 11)

Female. *Head:* eyes separated by distance equal to one facet diameter; interocular suture absent; eye bridge with four rows of facets; frons with median band of hair extending posteriorly to below level of center of eye bridge, not joining hair area of vertex; labellum with two spines; palpus about one-third the length of antenna, ratio of segments 5:7:7:9. Antenna with 16 segments, terminal three subequal in size, separated; sensory filaments Y-shaped. *Wing:* Sc ending before base of R_1; ratio of $R_{2+3}:R_2:R_3=8:6:11$, ratio of $M_{1+2}:M_1:M_2=6:16:14$. *Genitalia* as figured; apex of subgenital plate with rectangular concavity; V-shaped structure on internal face of plate; genital digit absent.

Measurements: holotype, antenna 0.8 mm.; wing length 1.4 mm.; wing width 0.6 mm. Paratypes, wing length 1.4–1.5 mm.; wing width 0.5–0.6 mm.

Male unknown.

Holotype female (U.S. National Museum): CHAGUARAMAS, U.S. NAVAL STATION, TRINIDAD, February 27, 1956, light trap, (T. H. G. Aitken). Paratypes, 10 females: Chaguaramas, U.S. Naval Station, Trinidad, VI-15-56, XI-9-56; Macqueripe, U.S. Naval Station, Trinidad, X-19-56; Tucker Valley, U.S. Naval Station, Trinidad, X-5-56, XI-9-56, XII-17-56. Other specimens: CANAL ZONE; Ft. Kobbe, IX-50, light trap; Ft. Claiton, II-2-56,

light trap; Mojinga Swamp, VII-15-52, light trap. PANAMA; Buena Vista, Transisthmian Hwy., Colon Prov., VIII-30-56, at light.

Distribution: Trinidad, Canal Zone, Panama.

Psychoda aitkeni is a common species in Trinidad and Panama occurring in quite large numbers in light trap collections. Only two other species of this area are more numerous in collections studied.

PSYCHODA PLAESIA Quate

Psychoda plaesia Quate, 1959, Insects of Micronesia (Bishop Museum), 12(4). In press.

Specimens examined: CANAL ZONE: Ft. Kobbe, IX-50, light trap.

Distribution: Canal Zone, Micronesia.

The wide distribution of this species is undoubtedly accounted for by rather recent dispersal by commercial transportation. Other species of the genus (e.g. *P. rarotongensis* Satchell) have a similar range.

KEY TO TRINIDAD SPECIES OF PSYCHODA

1. Bases of veins R_3 and M_2 lacking, bifurcations therefore incomplete....2
   Bases of veins R_3 and M_2 complete or only weakened at bifurcation.....3
2. Antennal segments 15 and 16 subequal in size.....*ichthycerca* Quate
   Antennal segment 15 about half the size of 16.....*zetoscota* Quate
3. Antenna with 14 or 15 segments.....4
   Antenna with 16 segments.....8
4. Antenna with 14 apparent segments (may actually be 15 but 14 greatly reduced and fused to 13).....5
   Antenna with 15 well defined segments.....6
5. Female subgenital plate hemispherical in general outline; aedeagus of male genitalia with small lateral shaft adjacent to main shaft near its center .....*rarotongensis* Satchell
   Female subgenital plate rectangular apically in general outline; aedeagus of male consisting only of simple main shaft.....*cochlearia* Satchell
6. Vein R_5 (vein ending in wing tip) not noticeably thicker than other veins; female subgenital plate with deep apical concavity.....7
   Vein R_5 definitely thicker than other veins; female subgenital plate with weak apical concavity.....*platilobata* Tokunaga
7. Female subgenital plate V-shaped, male aedeagus with lateral shaft straight and rounded at tip.....*alternata* Say
   Female subgenital plate Y-shaped; male aedeagus with lateral shaft curved and sharply pointed at tip.....*alternicula* Quate
8. Antenna segments 14 and 15 fused or partly fused together.....9
   Apical antennal segments clearly separated from each other.....10
9. Genital digit long, extending well beyond apex of subgenital plate; internal face of subgenital plate with pair of sac-like expansions marked with fenestra on either side of midline (male unknown)..*gehrkeae* Quate

Genital digit not extending beyond apex of subgenital plate; plate without sac-like lobes on internal face (male unknown) ..... *scotina* Quate

10. Female subgenital plate with large, rectangular apical concavity (male unknown) ..... *aitkeni* Quate

Female subgenital plate with very shallow apical concavity; male aedeagus with long, sickle-like lateral shaft, surstyle short and stocky, only little longer than dististyle ..... *plaesia* Quate

The following species have been recorded from the northern Neotropical region, but the brevity of the original descriptions and lack of specimens preclude their redescription and proper placement at the present time. (Williston's species are represented by single specimens only in the British Museum (Nat. Hist.) and unique type specimens, quite understandably, are not subject to loan.)

Psychoda angustipennis Williston, 1896, Trans. Ent. Soc. London, 1896:284. St. Vincent, Lesser Antilles. Type: Brit. Mus. (Nat. Hist.).

Psychoda antennalis Williston, 1896, Trans. Ent. So. London, 1896:283. St. Vincent. Type: Brit. Mus. (Nat. Hist.).

Psychoda atraseta Rapp, 1945, Jour. N.Y. Ent. Soc. 53:310. Barro Colorado I., Canal Zone. Type: Amer. Mus. Nat. Hist.

Psychoda brevitarsa Rapp, 1945, Jour. N.Y. Ent. Soc. 53:310. Barro Colorado I. Type: Amer. Mus. Nat. Hist.

Psychoda eburna Rapp, 1945, Jour. N.Y. Ent. Soc. 53:309. Barro Colorado I. Type: Amer. Mus. Nat. Hist.

Psychoda maculosa Rapp, 1945, Jour. N.Y. Ent. Soc. 53:309. Barro Colorado I. Type: Amer. Mus. Nat. Hist.

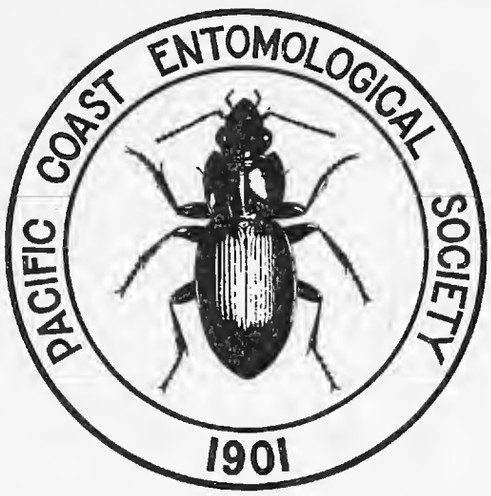
Psychoda pallens Williston, 1896, Trans. Ent. Soc. London, 1896:283. St. Vincent. Type: Brit. Mus. (Nat. Hist.).

Psychoda punctatella Townsend, 1897, Ann. Mag. Nat. Hist. ser. 6, 20:19. Vera Cruz, Mexico. Type: site unknown.

SUBTROPICAL FRUIT PESTS. By Walter Ebeling. vi + 436 pp. 160 black-and-white illus. 8 color plates. University of California Division of Agricultural Sciences. May, 1959. Price $7.00.

This complete reorganization and updating of Professor Ebeling's earlier work, "Subtropical Entomology," contains sections on control methods and materials, biology of citrus pests and biology of pests affecting non-citrus fruits. Separate chapters deal with citrus pests in the United States and in other countries, pests of avocado, grape, walnut, almond, pecan, olive, fig, date and minor subtropical fruits. Other topics include legislation and organizational controls, general artificial control, spray oils, fumigants, equipment and biological control. The book is intended for use as a reference work and practical guide for agricultural entomologists, chemical companies, pest control operators, agricultural extension workers, fruit growers, etc.—*Acting ed.*

* New names in bold face, synonyms and homonyms in italics.



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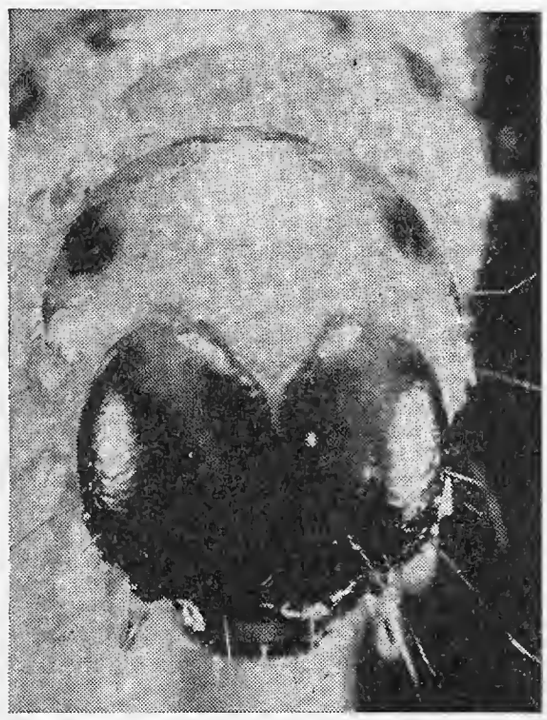

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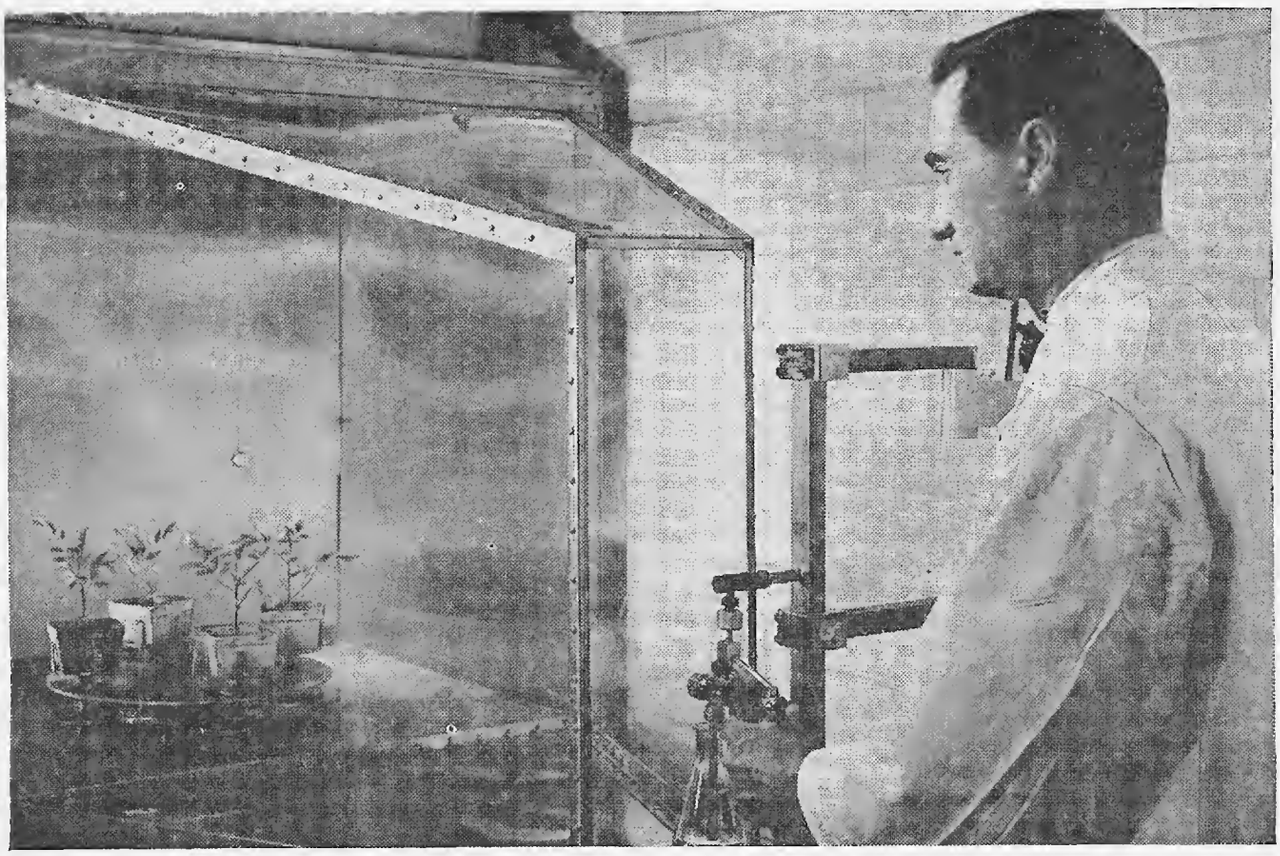

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Figs – For control of dried fruit beetles and vinegar flies. Use Emulsifiable Liquid or dusts at recommended rates. Apply when necessary up to 3 days from harvest.

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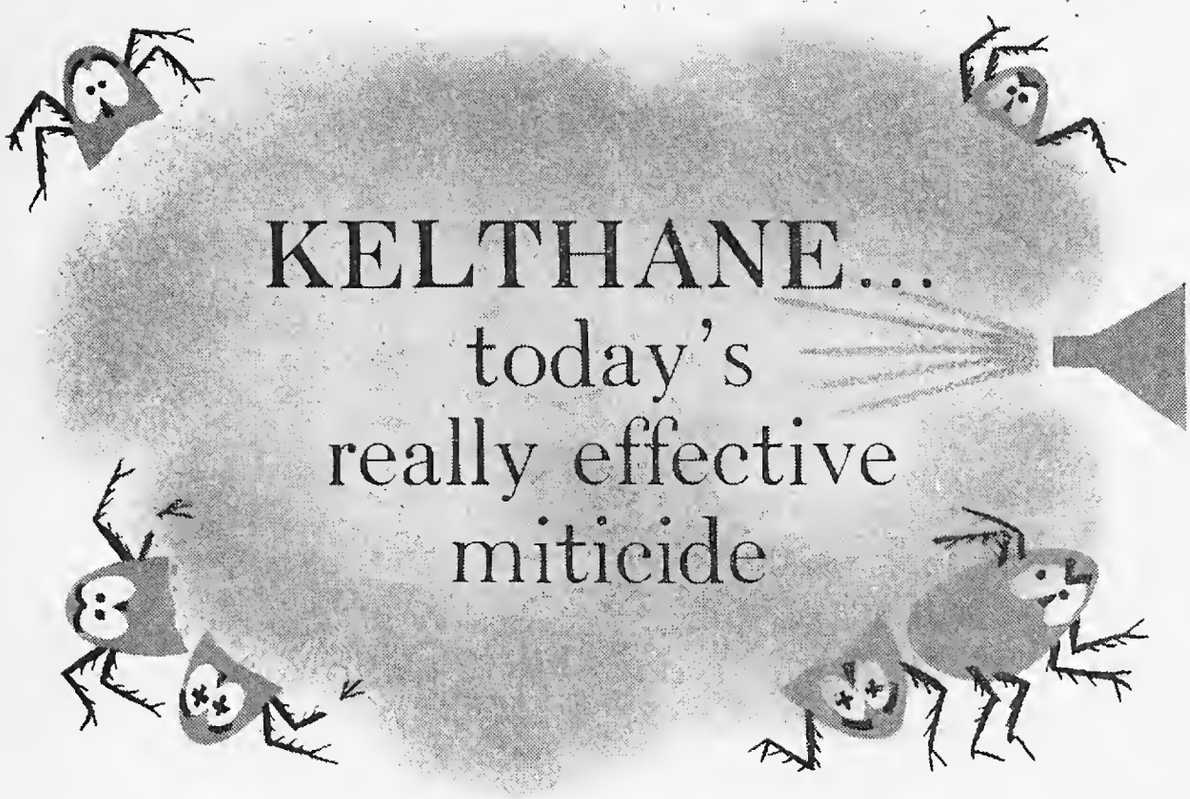

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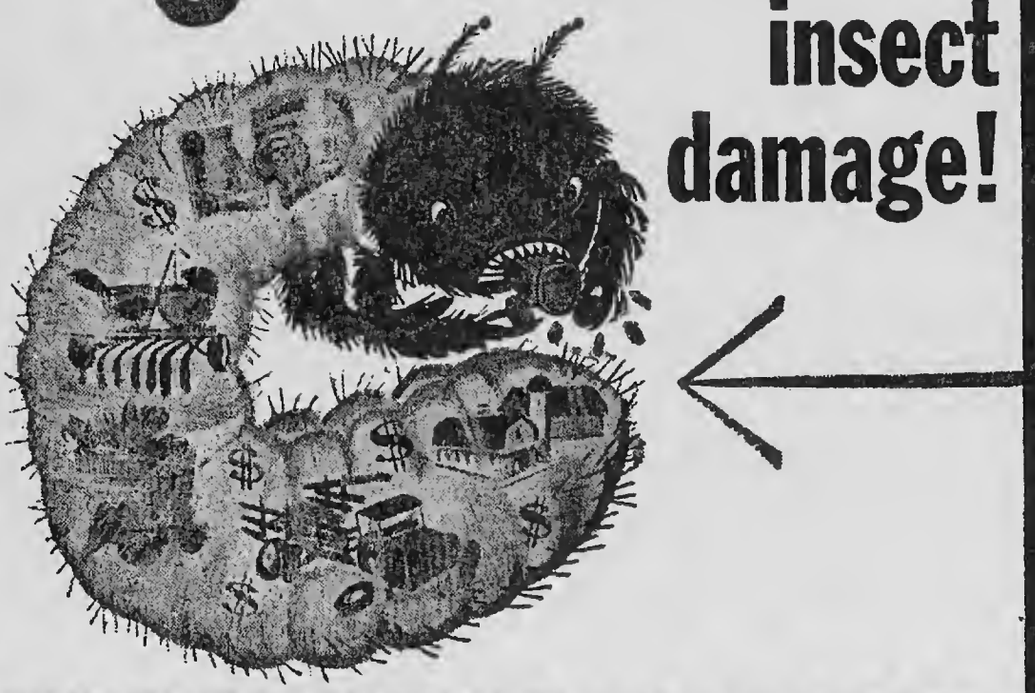

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